ELEMENTS

OF THE

ART OF DYEING.

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TRANSLATED FROM THE FRENCH

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ELEMENTS OF THE ART OF DYEING.

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CHAPTER I.

Of the Processes for dyeing Black.

WE know but very few substances capable of affording by themselves a permanent black, and these have been tried only on linen and cotton. The juice of the cashew-nut, or *anacardium* of India, communicates a black colour, that will not wash out, and even

resists boiling with soap or alkalis. It is used for marking linen. The *anacardium occidentale* affords likewise a durable dye, but it is merely of a brownish colour.

The juice of the *toxicodendron* produces nearly the same effect. That of the stalks of the hop-plant gives a very durable brownish red colour. The juice of the sloe affords a pale tint of a brownish hue, which becomes deeper after having been repeatedly washed with soap, and afterwards wetted with a solution of alkali. On boiling sloes, their juice becomes red, and the red tinge, which in that state it imparts to linen, is converted by washing with soap into a blueish colour of some durability [a].

According to Linnæus [b], the juice of the berries of the *actæa spicata* or *cristophoriana* affords a black ink with alum; and that of the berries of the *impetrum procumbens*, or *erica baccifera nigra*, a black colour inclining to purple when alum is mixed with it.

In the Brasils there grows a tree called by botanists *pomifera indica tinctoria*, or *genipa americana*, the berries and leaves of which afford a blue black that resists the action of soap.

[a] Lewis's Philosophical Commerce of Arts. vol. ii.

[b] Amœnitates academicæ.

The

The methods of obtaining a black colour which I have juſt recounted, cannot be employed in dyeing, becauſe the ſubſtances from which it is procured are not to be gathered in ſufficient quantity to ſupply the demands of the art, and the black which they afford is by no means comparable to that formed in the common proceſſes of the dye-houſe. All black colours, therefore, are the effects of combination. To produce them, the black particles formed by the union of the aſtringent principle with the oxyd of iron held in ſolution by an acid, are fixed on the ſtuff.

What I have already ſaid on the aſtringent property, and the manner in which aſtringents act on the oxyd of iron, and combine with it, to form black particles, in the fifth chapter of the firſt ſection of the former volume may be referred to: but it is to be obſerved, that when the particles are precipitated from the mixture of an aſtringent and a ſolution of iron, they have only a blue colour; if they be then left expoſed to the air, and moiſtened with water, their colour grows deeper, but ſtill the blue is diſtinguiſhable in it. The ſtuff itſelf then contributes to increaſe the intenſity of the black, whether it be, that in this ſtate of combination, it undergoes a ſlight combuſtion, or

that the colouring particles undergo a further degree of combuſtion from preſenting a larger ſurface to the air: for without the action of the air a fine black cannot be obtained, on which account, the operations about to be deſcribed are performed at different intervals, during which the ſtuff is taken out of the bath, that it may be expoſed to the air. I have aſcertained, that black ſtuffs placed in contact with pure air diminiſh its volume, and of courſe abſorb a certain quantity of it.

According to the proceſs deſcribed by Hellot [c], woollen cloth to be dyed black, ought to have received the deepeſt blue tint, or mazarin blue, to have been waſhed in the river as ſoon as taken out of the vat, and afterwards cleanſed at the fulling-mill.

For a hundred pounds of ſtuff, ten pounds of logwood, and ten pounds of aleppo galls powdered, are put into a bag, and boiled for twelve hours in a middle ſized copper, with a ſufficient quantity of water. One third of this bath is put into another copper with two pounds of verdegris, and into this the ſtuff is put, ſtirring it continually for two hours, obſerving to keep the bath very hot without

[c] L'art de la Teinture en Laine, &c.

letting

letting it boil. The ſtuff is then taken out, and a portion of the bath equal to the former, is put into the copper with eight pounds of vitriol or ſulphat of iron. The fire is now to be diminiſhed, and the bath ſuffered to cool for half an hour, whilſt the vitriol diſſolves; when the ſtuff is again put in, moved about well for an hour, and then taken out to air. Laſtly, the remainder of the bath is added, taking care, that the bag be well preſſed out. Fifteen or twenty pounds of ſumach are now put in, and the bath is made to give one boil, which is immediately ſtopped with a little cold water: two pounds more of ſulphat of iron are added, and the ſtuff is kept another hour. The ſtuff is now waſhed, aired, and again put into the copper, conſtantly ſtirring it for an hour: it is then carried to the river, well waſhed, and fulled. When the water comes off clear, another bath is prepared with weld, which is made to boil for a moment, and after being cooled, the ſtuff is paſſed through it, to ſoften it, and render the black more firm. In this manner a very beautiful black is obtained, without making the ſtuff too harſh.

In general more ſimple proceſſes are employed. Thus blue cloth is merely boiled in a bath of galls for two hours; it is then kept

two hours in the bath of logwood and fulphat of iron, without boiling; and afterwards wafhed and fulled.

Mr. Hellot has found the following method anfwer. For fifteen ells of deep blue cloth, a bath is to be made with a pound and half of yellow wood, five pounds of logwood, and ten pounds of fumach. After having boiled the cloth in this for three hours, it is taken out, ten pounds of fulphat of iron are put into the copper, and the cloth is kept in it two hours longer: it is then aired, put into the bath again for another hour, and afterwards wafhed and fulled. This black is lefs velvety than that of the procefs firft defcribed. The fame gentleman has found by experience, that the maddering prefcribed by the ancient regulation tends only to give a reddifh caft to the black, which is much more beautiful and velvety without madder.

Black may be dyed without a blue ground, and this is done for ftuffs of low price. In this cafe a *root colour ground* is firft given them, that is, they are dyed fawn colour with green walnut-peels, or the root of the walnut-tree; they are then blackened as directed above, or in fome other manner; for it is obvious, that black may be obtained by various proceffes.

Logwood

Logwood increases the beauty of the black dye; but the quantity of galls may be diminished by increasing that of the sumach, which indeed may be used altogether instead of them, as is done in some eminent manufactories.

The proportions most generally adopted by the english dyers are, according to Lewis, for a hundred pounds of woollen cloth, dyed first a deep blue, about five pounds of sulphat of iron, five pounds of galls, and thirty of logwood. They begin with galling the cloth, and then pass it through the decoction of logwood, to which the sulphat of iron has been added.

When the cloth is completely dyed, it is washed in a river, and fulled till the water comes off clear and colourless. Some recommend fine cloths to be fulled with soap-suds: but this operation requires an experienced workman, to cleanse the cloth perfectly of the soap. Many advise, to give the cloth a dip in a bath of weld, when it comes from the fulling-mill, which they say softens it, and at the same time fixes the black. Lewis says, that the weld bath is totally useless when the cloth has been treated with soap-suds, though in other cases it may be of advantage: he does not, however, ascribe its effects to any quality

of the weld, but to the alkali with which the dyers commonly prepare its decoction. Yet the weld itſelf may act by diſſolving the black particles which are not fixed in the cloth by its attraction for them.

It is ſaid in the Stockholm Tranſactions for 1753, that *uva urſi*, gathered in autumn, and carefully dried ſo that the leaves may remain green, may be employed inſtead of galls. The method there directed is to boil a hundred pounds of wool, with ſixteen of ſulphat of iron and eight of tartar, for two hours. The next day the cloth is to be rinſed as after aluming. A hundred and fifty pounds of uva urſi are then to be boiled in water for two hours, and after being taken out, a little madder is to be added to the liquor, at the ſame time putting in the cloth, which is to remain there an hour and half, or an hour and three quarters, after which it is to be rinſed in water. Lewis obſerves, that this proceſs gives a pretty good black to blue cloth, but to white only a deep brown, and that the madder and tartar are uſeleſs. The uva urſi precipitates the ſulphat of iron in large black grains, which diffuſe themſelves through the water.

In dyeing ſilk black, different operations are to be diſtinguiſhed: boiling the ſilk, galling it, the

the preparation of the bath, the operation of dyeing, and ſoftening the black.

Silk, as has been obſerved in the preceding volume, contains naturally a ſubſtance called its gum, which gives it that ſtiffneſs and elaſticity obſerved in its natural ſtate. This ſubſtance does not increaſe the ſtrength of the ſilk, which is then called raw; on the contrary, it renders it more liable to wear out from the ſtiffneſs it imparts to it: and though raw ſilk takes a black colour with more facility, than ſilk which has been ſcoured or diveſted of its gum, that black is much leſs perfect with reſpect to intenſity, and reſiſts the reactives calculated to diſſolve the colouring matter much leſs powerfully.

To cleanſe ſilk intended to be dyed black, it is commonly boiled four or five hours, with a fifth of its weight of white ſoap, after which it is beetled, and carefully waſhed.

For galling the ſilk, nearly three fourths of its weight of galls are boiled for three or four hours: but as aleppo galls are dear, a greater or leſs portion of white galls, or even of an inferior kind called berry or apple galls, is mixed with them. The proportion commonly uſed at Paris is two parts of aleppo galls to eight or ten of berry galls. After the boiling,

the liquor is left at reſt about two hours, that the galls may ſubſide: the ſilk is put into the bath, and left there from twelve to thirty-ſix hours: it is then taken out, and waſhed in the river.

Silk being capable of combining with more or leſs of the aſtringent principle, whence its weight receives a conſiderable augmentation, not from the weight of the aſtringent principle alone, but alſo from that of the colouring matter, which fixes in it in proportion to the quantity of the aſtringent principle combined with it, the proceſſes for dyeing it are varied, according as the operator is deſirous of rendering the ſilk more or leſs weighty. This requires ſome explanation.

Silks are ſold in two different ways; by weight, and by meaſure. This formerly diſtinguiſhed the ſilk trade of Lyons from that of Tours; ſilks being ſold at the former place by meaſure, at the latter by weight. It was the intereſt, therefore, of the manufacturer of Tours to increaſe the weight, and of the manufacturer of Lyons to be ſparing of his ingredients. Hence the diſtinction of light black and heavy black. At preſent both methods of dyeing are followed at Lyons, as ſilks are ſold there in both ways.

A pound

'A pound of ſilk loſes nearly one fourth of its weight in the boiling (cuite) when complete; and it recovers in the light black, and the galling which precedes it, an ounce and half, or two ounces; ſo that the original pound is reduced to about fourteen ounces: but in the heavy black this ſame pound is increaſed in weight to twenty or twenty-two ounces, or even more, ſo that the buyer, deceived by the low price at which it is offered him, pays in every pound for ſeveral ounces of a ſubſtance which is not merely uſeleſs, but is even injurious to the beauty of the colour and the ſtrength of the ſtuff. The dyers of Tours, who deal with that honeſty which renders trade honourable, and is the chief ſupport of credit, raiſe the original pound to fifteen or ſixteen ounces only. The black which is greatly overcharged, is ſtyled engliſh black, as it is pretended to have come from England. As the black which is much over-charged is never of a fine colour, it is generally employed for the woof, and covered with a warp of a fine black.'

The difference of the proceſs for obtaining heavy black conſiſts in leaving the ſilk a longer time in the gall-liquor, in repeating the galling, and dipping the ſilk in the dye a greater number of times, leaving it in this alſo a conſider-

able

able while. The firſt galling is commonly performed with galls which had been already uſed, freſh ones being taken for the ſecond. But this method would be inſufficient to give ſo great a ſurcharge as we find in the engliſh black. For this, the ſilk is galled raw, and afterwards rendered ſupple by wringing with the pin.

Silk-dyers preſerve a vat for the black, and its compoſition, greatly overcharged, varies in different dye-houſes. Theſe vats have commonly been ſet for many years, and when the black dye is exhauſted, it is renewed by what is called a brevet. When the grounds which accumulate in them become too conſiderable in quantity they are taken out, ſo that after a time nothing remains of ſeveral of the ingredients which compoſed the original bath, but which are not uſed in the brevet. The deſcription of a bath and brevet of this kind may be ſeen in Macquer [d]. In this proceſs there are ſeeds of fenugreek, fleawort, cummin, colocynth, buckthorn berries, agaric, nitre, ammoniacal muriat, ſal gem, litharge, antimony, lead ore, orpiment, corroſive muriat of mercury, &c. Macquer confeſſes, that many of

[d] Art de la Teinture en Soie.

theſe

these ingredients are useless; in fact, several of them are no longer employed: but the compositions of every country, and indeed of every dye-house, differ.

Iron filings are generally added to the dye bath; but some dyers, particularly at Tours, use in its stead the powder found in the troughs of cutlers grindstones [c]. The action of this powder depends probably on the particles of iron it contains, which are in a state of extreme division.

Whilst the silk is preparing for dyeing the bath is heated, taking care to stir it occasionlly, that the grounds which fall to the bottom may not acquire too much heat. This bath ought never to be heated so far as to boil. Gum and solution of iron are added in greater or less proportions, according to the different processes, and when it is judged that the gum is dissolved, and the bath is near boiling, it is left to settle for about an hour. The silk is then dipped into it, being, in general, first divided into three parts, each of which is put into the bath successively. Each part is wrung gently three times, and hung up to air after

[c] This is known among our workmen by the name of *Slippe*. T.

each wringing. The purpofe of this operation is to fqueeze out the liquor with which the filk is impregnated, and which is exhaufted, that it may imbibe frefh, and more efpecially to expofe the filk to the action of the air, which renders the black deeper.

After each portion of the filk has had three wringings, it is neceffary to heat the bath anew, putting in gum and fulphat of iron as the firft time; and the operation performed in the interval between two heatings, is called a *fire* (un feu). The light black has only two fires; but the heavy requires three, and for this the filk is fuffered to remain in the bath about twelve hours after the laft fire. Sixty pounds of filk, termed a copper, are commonly dyed at one operation. If only half that quantity be dyed, one fire is fufficient for the light black.

When the operation of dyeing is finifhed, fome cold water is put into a back, and in this the filk is rinfed (difbrodé) by turning or fhaking over.

Silk, when taken out of the black dye is extremely harfh. The operation by which it is deprived of this quality is ftyled *foftening*. For this purpofe a folution of four or five pounds of foap to every hundred pounds of

filk,

ſilk, is poured through a cloth into a large veſſel of water: being well mixed, the ſilk is put in and left about a quarter of an hour, after which it is wrung out and dried.

To dye raw ſilk, it is galled cold in the gall bath which has already been uſed for ſcouring ſilk. Silk with the natural yellow hue is preferred for this purpoſe. It muſt be remarked, that if you would preſerve a part of the gum of the ſilk, and afterwards ſoften it, the galling ſhould be performed in a warm bath as uſual: but here, where it is intended to preſerve the whole of the gum, and the claſticity which it communicates to the ſilk, the galling is performed cold. If the gall liquor be weak, the ſilk is left in it for ſeveral days.

The ſilk thus prepared and waſhed, readily takes the black dye, and the rinſings, to which ſulphat of iron may be added, ſuffices to communicate it. This dyeing is performed cold; but it requires more or leſs time according to the ſtrength of the rinſings. Sometimes three or four days are neceſſary; after which it is waſhed, giving it one or two beetlings, and is dried without wringing, that it may not be ſoftened.

Raw ſilk may be dyed more ſpeedily by turning or ſhaking it over in the cold bath after galling, and

and airing it, repeating these operations a few times; after which it is to be washed and dried as above.

Macquer describes a more simple process for the black, with which they dye velvet at Genoa, and he says, that this process rendered even still more simple has succeeded completely at Tours. It is as follows.

For a hundred pounds of silk, twenty pounds of aleppo galls in powder are to be boiled an hour in a sufficient quantity of water. The bath is then left to settle till all the galls have fallen to the bottom, when they are taken out, and two pounds and a half of english vitriol, twelve pounds of iron filings, and twenty pounds of gum collected from the trees of the country, are put into a copper cullender with two handles, and immersed in the bath. The cullender is supported by sticks, so as not to touch the bottom, and an hour is allowed for dissolving the gum, which is occasionally stirred. If at the end of the hour any gum remain in the cullender, it is a proof, that the bath which contains two hogsheads (deux muids) has acquired as much as is necessary: if, on the contrary, all the gum be dissolved, three or four pounds more may be added. The cullender is still left in the copper, taking it out

out only whilſt dyeing, and putting it in again, as ſoon as that operation is over. The copper muſt be kept hot the whole time, but without boiling. The ſilk is galled with one third of aleppo galls, leaving it in the liquor ſix hours the firſt time, and twelve hours the ſecond. The reſt of the proceſs is conducted in the common way.

Lewis ſays, that he has tried this proceſs in the ſmall way, and by adding more and more ſulphat of iron, and repeating the immerſions of the ſilk a great number of times, he has at length obtained a fine black.

In fact, the ſulphat of iron appears to be in too ſmall proportion in the proceſs deſcribed by Macquer, and inconveniences were no doubt found to attend it, as it is no longer followed at Tours. Lewis thinks that the gum is uſeleſs, and that it is all carried off in waſhing the ſilk: but it is probable, that if he had continued to dye in the ſame bath, he would have found it contribute to keep it up. The quantity above directed appears, however, to be exceſſive. If the quantity of gum be leſſened, it would be particularly uſeful to add the ſulphat of iron in ſeparate portions after each fire.

Lewis remarks alſo, that though white ſilk may be dyed a good black, without uſing either logwood or verdegris, the addition of thoſe two ingredients contributes greatly to improve the colour in ſilk as well as in wool.

The quantity of galls uſed in dyeing ſilk black renders it very expenſive, as their price has been conſiderably raiſed. It is of conſequence therefore, to find ſome method of leſſening their quantity. The following proceſs is taken from a memoir of Mr. Anglês, who was a competitor for the prize propoſed in 1776 by the academy of Lyons, of which this was the object.

Silk carefully boiled (cuite) and waſhed in the river, is to be immerſed in a ſtrong decoction of green walnut peels, and left in it till the colour of the bath is exhauſted. It is then taken out, ſlightly rung with the pin, dried, and waſhed in the river. The decoction of walnut peels is made by boiling a full quarter of an hour, when it is taken from the fire, and ſuffered to ſubſide before dipping the ſilk, which has been previouſly immerſed in warm water. A blue ground is next given by means of logwood and verdegris. For every pound of ſilk, an ounce of verdegris is diſſolved in cold water, the ſilk is left in this ſolution two hours,

hours, it is then dipped in a ſtrong decoction of logwood, wrung out ſlightly, and dried before it is waſhed at the river. For light blacks, galling may be altogether omitted; but to obtain a heavy black, half a pound of galls muſt be uſed for every pound of ſilk.

To prepare the bath, two pounds of galls and three of ſumach are macerated in twenty-five gallons of water over a ſlow fire, for twelve hours. After ſtraining, three pounds of ſulphat of iron and as much gum arabic are diſſolved in it. In this ſolution the ſilk is dipped at two different times, leaving it in two hours each time, taking care to air it after the firſt dipping, and to dry it before giving the ſecond fire, when it is to be again aired and dried: it is then beetled twice at the river; after which a third fire is given it, in the ſame manner as before, except that it is left in the bath four or five hours. When drained and dried, it is again beetled twice at the river. Care muſt be taken, that the heat, during the operation do not exceed the mean term between freezing and boiling water, or forty degrees of Reaumur's thermometer (122 degrees Farhenheit); and before the laſt two

fires, half a pound of ſulphat of iron and as much gum arabic muſt be added.

For removing the harſhneſs ſilk acquires from the black dye, Mr. Anglês prefers the decoction of weld to the ſolution of ſoap.

Mr. Anglês ſays, that if ſilk be dyed blue with indigo previous to its being dipped for black, it will take only a mealy black, but that a velvety black will be obtained if it be prepared with logwood and verdegris. He ſays alſo, that green walnut peels ſoften the ſilk. Though a fine black may be procured from green walnut peels, and the bath above deſcribed, he notwithſtanding adds logwood and verdegris, that he may not be obliged to uſe a large quantity of ſulphat of iron, which weakens the ſilk too much. Laſtly, he thinks, that galls ſerve only to give the ſilk weight, and that ſumach is ſufficient for the dye.

Linen and cotton do not eaſily take a black of any intenſity that will reſiſt ſoap, ſo that to dye them black, particular proceſſes are neceſſary, and hitherto few dyes have been found to give ſatisfaction.

For dyeing cotton and linen black, a ſolution of iron is uſed which is kept in a caſk, called the *black caſk*. This ſolution is prepared with vinegar or ſmall beer, or ſmall wine made

made from the grapes after they have been preſſed by adding water to them, which is ſoured with rye meal, or ſome other ingredient, in order to procure an acid liquid at a low price. Pieces of old iron are thrown into this liquor, which is left to ſtand till wanted, but never uſed in leſs than ſix weeks or two months. To this bath aſtringents are frequently added, particularly the decoction of alder bark, which of itſelf has the property of diſſolving a conſiderable portion of oxyd of iron.

Mr. le Pileur d'Apligny deſcribes[f] the method followed at Rouen, for dyeing linen and cotton threads. They are firſt dyed ſky blue in the vat, then wrung out and dried. They are next galled, uſing four ounces of galls to every pound of thread, and leaving them twenty-four hours in the gall liquor, after which they are wrung out and dried again.

About five quarts of the liquor of the black caſk for every pound, are then poured into a tub, in which the thread is worked with the hand pound by pound about a quarter of an hour, when it is wrung out and aired. This operation is repeated twice, adding each time a freſh quantity of the black bath, which ought

[f] L'Art de la Teinture des Fils & Etoffes de Coton.

to be carefully ſcummed. After this it is again aired, wrung out, waſhed at the river to cleanſe it well, and dried.

When this thread is to be dyed, a pound of alder bark for every pound of thread is boiled for an hour in a ſufficient quantity of water. About half the bath that ſerved for the galling, and half as much ſumach as alder bark are then added, and the whole boiled together for two hours, and then ſtrained through a ſieve. When the liquor is cold the thread is put into it on the ſticks, and worked pound by pound, airing it from time to time: it is then let down into the bath again, left in it twenty-four hours, wrung out, and dried.

To ſoften this thread when it is dry, it is cuſtomary to ſoak and work it in the remains of a weld bath that has been uſed for other colours, adding to it a little logwood. From this it is taken out and wrung, and inſtantly put into a tub of warm water, into which has been poured an ounce of olive oil for every pound of thread. Laſtly, it is wrung out and dried.

For printing cottons black, a ſolution of iron in acetous acid is uſed, and the ſtuff is dipped in the madder bath. Mr. le Pileur d'Apligny deſcribes a proceſs in which he employs mad-

der

der alſo, for giving linen and cotton thread a black colour, which he ſpeaks of as very fine and durable.

The thread is firſt to be ſcoured as uſual, galled, then alumed, and afterwards dipped in the weld bath. When taken out of this bath, it is to be dyed in a decoction of logwood, to which a quarter of a pound of ſulphat of copper has been added for every pound of thread. After this, it is to be waſhed in the river, and wrung ſeveral times, but not too hard. Finally, it is dyed in a madder bath, in the proportion of half a pound to each pound of thread. That the black may not be liable to be diſcharged, the thread muſt be dipped in a bath of ſoap-ſuds.

The method followed at Mancheſter is thu deſcribed by Mr. Wilſon [g]. A galling is made with galls or ſumach, after which the ſtuff is dyed with the liquor of the bath, conſiſting of a ſolution of iron in vegetable acid, frequently compoſed of alder bark and iron, and then dipped in a decoction of logwood with a little verdegris. This proceſs is repeated till a deep black is obtained. It is neceſſary to waſh and dry after each operation.

[g] An eſſay on light and colours, and what the colouring matters are, that dye cotton and linen.

Mr. Guhliche deſcribes a ſolution of iron, on which he beſtows great encomiums [h]. He directs a pound of rice to be boiled in twelve or fifteen quarts *(meſures)* of water, till it is wholly diſſolved; into this ſolution is to be thrown as much old iron made red hot, as will come half way up to the ſurface of the liquor. This is to be done in a vat expoſed under cover to the air and light at leaſt a week. An equal quantity of red hot iron is thrown into as much warm vinegar as there was ſolution of rice, in another veſſel, and in like manner expoſed to the air and light. After ſome days the contents of the two veſſels are to be mixed together, and this mixture is to be left a week expoſed to the open air. The liquor is then to be decanted, and kept in a cloſe veſſel for uſe.

The author ſays, that for dyeing linen and cotton, nothing more is neceſſary than to leave them in this liquor, till they have acquired a ſufficient black, which will not require above twenty-four hours at moſt: that if the liquor do not contain enough of ferruginous particles, the ſtuff, after being taken out, muſt be put into a freſh portion of liquor: that, though

[h] Vollſtändiges Farbe und Blaichbuch, &c. band. ii.

it appear only of a blackiſh gray, it produces the fineſt and moſt permanent black: and that it may be advantageouſly ſubſtituted inſtead of ſulphat of iron for ſilk and wool, which only require to be dipped in a decoction of logwood when taken out of the bath, to give them a beautiful black.

The numerous experiments of Mr. Beunie have led to the reſults which I am about to lay before the reader, beginning with the preparations uſed by him in the two proceſſes which he deſcribes.

1. *Neutralized Alum.*

Diſſolve ten pounds of powdered alum in fourteen gallons of well-water: diſſolve alſo ten ounces of pot-aſh in ten quarts of well-water: let the latter ſolution ſtand ſome time to ſettle, and when it is clear, pour it into the former, ſtirring it conſtantly.

2. *Liquor of Braſil-Wood.*

Boil twenty-five pounds of braſil-wood in fifty quarts of well-water for one hour: ſtrain the decoction through a ſieve, or linen cloth: put fifty quarts more of well-water to the reſiduum, and boil it again: ſtrain this liquor, and put it into a caſk with the former.

3. *Infuſion of Galls.*

Infuſe four pounds of galls groſsly powdered in fifty quarts of warm water. More galls might be uſed, which would render the liquor better.

4. *Solution of Iron.*

Put into a caſk fifty gallons of good vinegar, fifteen pounds of iron filings, twenty-five pounds of old iron, and three pounds of common ſalt: draw off the vinegar occaſionally, and pour it into the caſk again. This ſolution will be fit for uſe in a month, but the older it is, the better.

5. *Another Liquor of Galls.*

Boil a hundred pounds of oak ſaw-duſt, or ſmall chips of oak, not lixiviated, in a hundred gallons of well-water, for two hours: preſs out the liquor and boil in it ten pounds of galls, and twenty-five pounds of logwood: ſtrain and keep for uſe. This bath is the better for keeping.

Proceſs for fine Goods.

Give your ſtuff an indigo ground, as deep poſſible in the warm vat; then dip into

No.

No. 1, wringing it a little, that the alum may penetrate it, and dry it in the ſhade. After this, ſoak it two hours, and rinſe it well. When it is half dry, boil it half an hour in No. 2, adding a quarter of an ounce of verdegris, rinſe it, and wring it well. It will now be a deep purple. When it is dry, ſoak it an hour in No. 3, taking care not to let it boil: take it out, and in a few hours put it again into No. 3, and afterwards into No. 4. Dry it, and then rinſe it till the water comes off clear.

Proceſs for low-priced Goods.

Dip your thread or cotton in No. 1, as above; then boil it in No. 2, with ſome verdegris; dip it next in No. 5, and laſtly in No. 4, obſerving the directions given above.

It is uſeful on many occaſions to give linen a print capable of reſiſting the action of ſoap or ley, to ſerve as a mark. Of all the methods that have been tried, that uſed in England appears to be the moſt effectual. A ſolution of ſilver is diluted with diſtilled water: in this a little gum is diſſolved: the end of the cloth on which the mark is to be impreſſed, is impregnated with a ſolution of iſinglaſs, and on this the gummy ſolution of ſilver is applied. This mark ſoon grows black.

CHAP. II.

Obſervations on the Proceſſes for Dyeing Black.

IT appears, from the preceding deſcriptions of the proceſſes, that experience has taught, that they ſhould vary according to the nature of the ſtuffs to be dyed. I ſhall now endeavour to aſcertain the circumſtances which muſt occaſion a variation in the proceſſes, by recurring to the theory laid down in the chapter on aſtringents, and ſome obſervations inſerted in this ſection.

The dyeing of wool is the moſt eaſy; wool having a greater attraction for the black particles than ſilk or cotton: yet particular attention is neceſſary to obtain a deep black, which may be permanent, and poſſeſſed of the luſtre peculiar to that colour.

All aſtringents are capable of ſtriking a black on wool: but the black ſtruck with oak bark is not ſo durable as that ſtruck with galls, though it is equally deep, if a ſufficient quantity of the bark be employed.

Aſtringents differ from one another chiefly by the permanency of the black they produce, and

and the quantity of the aſtringent principle they contain. To produce an equal intenſity of colour, the quantity uſed ought to be in proportion to the quantity of their aſtringent principle. Logwood will not of itſelf ſtrike a deep and laſting black, but in conjunction with galls, or ſumach, it adds luſtre to the colour. Of all the aſtringents we know, ſumach approaches neareſt to galls, with regard to the quality of the black it gives; and it appears to be even equal to them in that reſpect, but it does not contain ſo large a proportion of the aſtringent principle.

The proper quantity of vitriol or ſulphat of iron, ſeems to be that which anſwers to the quantity of the aſtringent principle, ſo that the whole of the iron be precipitated by the aſtringent, and the whole of the aſtringent taken up by its combination with the iron: but as it is impracticable to hit this point with preciſion, it is better, that the ſulphat of iron ſhould be predominant, becauſe the aſtringent principle when it is ſuperabundant, oppoſes the precipitation of the black colouring particles, and even poſſeſſes the property of diſſolving them.

This property of the aſtringent principle is ſo active, that if a pattern of black cloth be boiled,

boiled with galls, it will be reduced to a gray; and it has been ſeen, in the chapter on aſtringents, that the firſt black particles formed on mixing a ſolution of ſulphat of iron with an infuſion of galls were rediſſolved by the latter. This ſerves to explain an obſervation of Lewis, that if cloth be repeatedly dipped in the colouring bath after it has taken a good black, inſtead of the colour being heightened, it will be weakened, and become browniſh, and that too great a quantity of ingredients will produce the ſame effect; but in this the diſengaged ſulphuric acid concurs, as will be ſhewn.

Hence it follows, that when ſumach is uſed inſtead of galls the proportion muſt be increaſed, without increaſing that of the ſulphat of iron, taking into the calculation the logwood that is uſed with it.

To obtain a fine black, it is of advantage to give the cloth a blue ground, as then a leſs quantity of the ingredients will be required to produce a deep tint, and conſequently there will be leſs vitriol decompoſed by the aſtringent particles. Now by this decompoſition the ſulphuric acid is diſengaged; and if it happen to be concentrated to a certain degree, it acts upon the ſtuff, diminiſhes its ſoftneſs, and weakens it. It may even rediſſolve the

black

black particles which were fixed in it, or rather prevent them from fixing in ſufficient quantity.

A ground of any other dark colour may be given, particularly ſawn colour, but then the black will not be ſo fine.

In dyeing black, it is good to uſe a little verdegris; the oxyd of copper which it contains in greater or leſs quantity, favouring the precipitation of the black particles by combining with the ſulphuric acid. Probably that part of the verdegris which is in the ſtate of acetite of copper * is ſerviceable in the ſame way, the oxyd of copper combining with the ſulphuric acid, whilſt the acetous acid is diſengaged and aſſumes its place: but the acetous acid does not act upon the black particles. It appears from the experiments of Mr. Clegg, that the place of verdegris may be ſupplied by oxyd of copper precipitated from ſulphat of copper, or blue vitriol; and no doubt any other oxyd of copper would do equally well.

The proceſſes employed for dyeing wool would give only a ruſty black to ſilk, as Lewis has obſerved. Let us examine the differences which diſtinguiſh the proceſſes employed in dyeing ſilk.

* See the chapter on Verdegris, part i.

Silk is much leſs diſpoſed than wool to combine with the black colouring particles; and its union with them is much weaker, for the mineral acids, tartar, and alum, ſeparate them much more eaſily from ſilk than from wool.

On the other hand, ſilk is much more diſpoſed to combine with the aſtringent principle than wool. I have found by experience, that ſilk gains double the weight acquired by wool in the ſame galling. Some obſervations that I have made on this ſubject will not here be miſplaced. Silk galled with white galls acquired more weight than ſilk galled with black: but an equal weight of the latter produced with ſulphat of iron one fifth more of black precipitate, and ſilk treated with theſe galls gained in the dye-bath or *ſlat*, an increaſe of weight that compenſated the deficiency of weight in the galling. Silk treated with a quantity of ſumach double that of the galls was not ſo much increaſed in weight; but it acquired a little more in the bath, ſo that the ultimate difference of weight was inconſiderable.

It muſt be remembered, that the aſtringent has ſuch an attraction for the black particles, as in a certain degree to take them from the wool with which they were combined. Hence it

it may be conceived how the aſtringent combined with a ſtuff, communicates to it not only the property of decompoſing ſalts of iron to ſeize on their oxyd, but alſo of combining with the black particles already formed.

Silk, then, which has little attraction for the black particles, and much more for the aſtringent, ought to be firſt galled, which imparts to it the property of combining with the black particles. But though we may begin the dyeing of wool alſo by galling, this preliminary operation may be conſidered as at leaſt uſeleſs, ſince the mixture of the aſtringent with the ſulphat of iron will give it at once a fine black.

The ſlight diſpoſition of the black particles to fix on ſilk explains the compoſition of the bath employed. This compoſition is by no means uniform. I have compared ſeveral receipts, and have found them ſo different, and all of them ſo complex, that I could make choice of none: but it appeared to me, that the end attained by them in different ways was to make a bath, in which the black particles very abundant and near together, ſhould not be retained by an acid, and ſhould be held but weakly by the liquor. Hence 1ſt, the uſe of litharge, verdegris, and iron filings put into the bath: 2dly, the utility of gummy and muci-

laginous ſubſtances, which ſerve to prevent the black colouring particles, that ought to remain ſuſpended in the bath, from ſubſiding: 3dly, the advantages of an old bath, in which the colouring particles are accumulated in large quantity, and feebly retained: for it has been ſeen, that the black particles formed by the mixture of ſulphat of iron with an aſtringent, are not precipitated without difficulty, when the liquor is not diluted with a great deal of water.

This theory I have confirmed; and the following experiments have conducted me to a very ſimple proceſs. It muſt be remembered, that operations in the ſmall way require a larger proportion of the ingredients.

I galled an ounce of ſilk with an ounce of nut-galls, and made a bath with

Nut-galls....................one ounce,
Logwood....................one ounce,
Gum.........................two ounces,
.Sulphat of iron, or vitriol...half an ounce,
Verdegris....one dram twenty-four grains [a].

The ſilk being taken out and aired, was put again into the bath twice, adding each time one dram twenty-four grains of ſulphat of iron and

[a] For a compariſon of french with engliſh weights ſee end.

two

two of verdegris: after this it was dipped in weak ſoap-ſuds. The black obtained by this proceſs, was imperfect, and inclining to violet.

I repeated the operation with a bath compoſed of the ſame ingredients, but it was expoſed to the air for twenty days before it was uſed, and the verdegris was not put in till the inſtant of going to dye. This time I had a fine deep black.

I repeated theſe experiments ſubſtituting ſumach inſtead of galls; but I uſed double the quantity of ſumach, both for the galling and for the bath, without altering the quantities of the other ingredients; and obtained an imperfect black in the firſt method, but in the ſecond, as fine a black as with the galls.

This bath differs from that commonly uſed for hats, only in the proportions of the ingredients; and indeed the reſiduum of the hatters bath is employed with ſucceſs for dyeing ſilk ſtockings.

It appears to me beyond a doubt, that ſumach may be uſed inſtead of galls for dyeing ſilk and hats, with the ſimple precaution of taking double the quantity of ſumach: an important object, particularly at preſent when galls bear ſo high a price.

To explain in a fatisfactory manner the difference of the proceffes employed for linen and cotton, to which, like filk, the black particles adhere but weakly, is far from eafy: though I have found by experience, that cotton fimply galled acquired only a blackifh colour in the procefs which gave me a fine black with filk. I fhall offer a few conjectures on this fubject.

I have remarked, that the folution of fulphat of iron forms a precipitate when left expofed to the air, and that the iron in this cafe acquires a greater proportion of oxygen: but the folution in acetous acid, or other vegetable acids analogous to it, does not in fimilar circumftances form a precipitate, but only affumes a deeper hue. Befides, thefe acids take up a larger portion of iron than the fulphuric.

On the other hand, I have obferved, that iron highly oxydated has a great attraction for linen and cotton, producing in them fpots not eafily difcharged; and that in all the proceffes, the folution is directed to be left a long time expofed to the air, and even rufty old iron to be chofen.

Hence it appears to me, that the iron which is to enter into the compofition of the black particles, ought to retain more oxygen to unite with linen and cotton, than to unite with wool or

or ſilk: that a ſolution in vegetable acid, expoſed a long time to the air, poſſeſſes this advantage: and that, beſides, it leaves in the liquor that remains on dyeing, a weak acid, which does not act on the black particles.

This theory I ſought to confirm by the following experiment. I diſſolved iron in nitric acid, precipitated it by fixed alkali, and calcined it in a crucible. In this ſtate it is known to be ſcarcely ſoluble in the ſulphuric acid. With this calx I ſaturated vinegar as completely as poſſible, and dyed cotton, firſt alumed and afterwards galled, with the ſolution freſh made. After this firſt dyeing, I galled and dyed the cotton a ſecond time; when it had acquired as deep a black as the cotton to be met with in commerce, only it was a little harſh. A ſimilar experiment made with ſumach inſtead of galls, uſing double the quantity, was equally ſucceſsful.

It is difficult to obtain a fine black on linen, or cotton; but to come as near to it as may be, it is proper to give a blue ground as deep as poſſible, becauſe then, a ſmall quantity of colouring matter is ſufficient to produce a black, and perhaps the indigo itſelf contributes to fix the black particles. For common blacks, however, this would be too expenſive. The

galling is preceded by aluming, becauſe the alumine, which is thereby fixed, renders the galling more effectual. The place of galls, which bear a conſiderable price, is frequently ſupplied by oak bark, oak ſaw-duſt, ſumach, the cups and huſks of acorns, or other common aſtringents.

CHAP. III.

Of Gray.

THE ſhades of black are grays, from the deepeſt to the lighteſt.

Grays may be produced in two ways. In the firſt, a decoction is prepared from bruiſed galls, and the vitriol is diſſolved ſeparately. A bath is made proportionate to the quantity of ſtuff to be dyed of the lighteſt ſhade; and when it is ſo hot that the hand will juſt bear it, ſome of the decoction of galls, and ſome of the ſolution of vitriol, are poured in. Into this the wool or cloth is dipped. When it has attained the ſhade deſired, it is taken out, and more of the decoction, with more of the ſolution, is added to the ſame bath. Into this more cloth

cloth is dipped, to give it a deeper ſhade than the preceding. In the ſame manner the operator proceeds to the deepeſt ſhades, always adding ſome of each of the liquors: though for black gray, and other deep ſhades, it is beſt to give the cloth previouſly a blue ground more or leſs deep.

The ſecond method of producing gray, which Hellot prefers to that I have juſt deſcribed, becauſe in it the ſtuff takes the decoction of galls more firmly, and there is a greater certainty of putting no more ſulphat of iron than is neceſſary for the ſhade required, conſiſts in boiling for two hours the proper quantity of galls, bruiſed and encloſed in a thin linen bag: in this bath the cloth is to be boiled for an hour, being kept ſtirring, after which it is taken out: a little ſolution of vitriol is then added to the ſame bath, and the cloth that is to have the lighteſt ſhade is dipped in it. For the deeper ſhades more ſolution of iron is added.

In either of theſe methods we may begin with the deepeſt ſhades, if we be not confined to patterns which muſt be ſuited exactly. In the latter caſe each piece of ſtuff ſhould be left a longer or ſhorter time, till it has acquired the intended ſhade.

It is not poſſible to determine the proportions of the ingredients, the quantity of water, and the time neceſſary for all theſe operations: they muſt be judged of by the eye. If the bath be greatly loaded with colour, the wool muſt remain in it a leſs time: if, on the contrary, the bath begins to be exhauſted, a longer time is required. If we find the ſtuff not dark enough, it muſt be re-dipped a ſecond, a third time, &c. if it be too dark, it muſt be dipped into another hot bath, into which has been put a ſmall portion of decoction of galls, or into a bath of ſoap-ſuds, or of alum. If in this operation we go beyond the mark, the colour muſt be darkened as before; but repeating theſe operations is prejudicial to the ſtuff, ſo that we ſhould endeavour to catch the proper ſhade at once, by taking it out of the bath from time to time.

Care muſt be taken that the bath do not boil, and that it be rather warm than too hot. In whatever manner grays are dyed, they ſhould be immediately waſhed in a large body of water, and the darkeſt ſhould even be cleanſed with ſoap.

It is frequently required to give grays a tint of another colour, as a nut, agate, or reddiſh

caſt.

caſt. In this caſe, having given a tint more or leſs blue according to the object intended, the ſtuff is dipped in the remains of ſome cochineal liquor, that has ſerved for dyeing either ſcarlet or violet, adding to it galls, logwood, madder, &c. they are then browned more or leſs deep with ſolution of iron. For the nut-gray, yellow wood and logwood are added to the galls, and the ſtuff is dyed from white.

Silk takes all grays, except black gray, without previous aluming. The bath is compoſed of fuſtic, logwood, archil, and ſulphat of iron. Theſe ingredients are varied according to the tint to be given. Thus more archil is employed for grays that are to have a reddiſh caſt, more fuſtic for thoſe that ſhould incline to a ruſſet or green, and more logwood for thoſe that are to be of a darker gray. For iron gray, logwood and ſolution of iron only are uſed.

Black gray requires aluming; after which the ſilk is taken to the river, and then dipped in the weld bath. A part of this bath is thrown away, and its place ſupplied with logwood liquor. When the ſilk is impregnated with this, a ſufficient quantity of ſolution of iron is added, and as ſoon as it has acquired

acquired the proper ſhade, it is waſhed and wrung.

If the gray happens to be darker than it ought, the ſilk is dipped in a ſolution of tartar, and afterwards in warm water: and if by theſe means the colour be weakened too much, the ſilk is again dipped in a bath of freſh dye.

Linen and cotton have a blue ground given them for black-gray, iron-gray, and ſlate-gray, but for no other. All the ſhades require a galling proportionate to the gray to be produced. Gall-baths that had before ſerved for other purpoſes are frequently uſed.

When the thread has been galled, wrung, and dried, it is dipped on the ſticks in a tub of cold water, to which is added a proper quantity of the bath from the black caſk, and of a decoction of logwood. The thread is worked in this pound by pound, waſhed, and dried.

Mr. Pileur d'Apligny gives two other proceſſes for dyeing gray, which according to him, produce a more permanent colour.

1. The thread is galled, dipped in a very weak bath of the black caſk, and then maddered.

2. The thread is dipped in a very hot ſolution of tartar, wrung gently, and dried. It is then

then dyed in a decoction of logwood. After this operation the thread appears black; but, on working it attentively in warm soap-suds, the surplus of the dye is discharged, and it remains of a pleasing and durable slate-gray.

SECTION

SECTION II.

Of Blue.

CHAP. I.

Of Indigo.

INDIGO is a blue colouring ſubſtance extracted from a genus of plants, known by the name of *indigoferæ*, and *indigo*.

At St. Domingo, and the neighbouring colonies, two ſpecies of indigofera are diſtinguiſhed: the true and the baſtard. The firſt is a ſomewhat buſhy ſhrub, growing to the height of two or three feet: its leaves are round, pretty thick, ſmall, and greeniſh: its flowers reſemble thoſe of the pea, and are ſucceeded by long curved pods.

When the indigofera appears to be ripe, it is cut, and carried to the vats, where it is to undergo a fermentation, to which it is greatly diſpoſed. If it be perfectly ripe when cut, the indigo it affords is of a finer colour, but

much lefs in quantity, than if it be not arrived at a ftate of maturity: if it be over ripe, the quantity is ftill lefs, and its quality is bad.

There are three vats placed one over another at different heights, and near a refervoir of water. The firft is called the *fteeping vat* (trempoire). Into this the plant is put, after having filled it with water to a certain height: a brifk fermentation foon commences; and much fcum is formed. Mr. Quatremere fays, that the difengaged gas is inflammable.

When the indigo-maker finds the fermentation fufficiently advanced, and the colouring particles beginning to unite, he draws off the liquor into the fecond vat, called the *beating vat* (batterie) in which the liquor is beaten with inftruments contrived for that purpofe. Mr. le Blond afferts, in the obfervations fent by him to the academy of fciences, that this operation is intended to diffipate the carbonic acid formed by the fermentation, which would prevent the precipitation of the colouring particles. He fays, that the beating is not fufficient to procure the precipitation of all the colouring particles, and that a method has been tried in french Guiana, which, by producing a much more copious precipitate, revived the hopes of the colourifts, who were abandoning

abandoning this manufacture. This method consists in mixing with the liquor a quantity of lime-water, which absorbs its carbonic acid: but he thinks, that this should not be carried beyond a certain proportion, and that an excess of lime-water is prejudicial. This method is not new: it is mentioned by father Labat. Mr. Struve also has thought, that lime-water would favour the precipitation of the indigo, by seizing the carbonic acid which held it in solution [a].

When it is judged from the blue colour, that the liquor is sufficiently beaten, it is left at rest about two hours, that the colouring particles may begin to separate from the liquor, which contains a yellow extractive matter, and it is then drawn off into a third vat, called the *settling vat* (diablotin). The colouring particles are left to settle in this vat, the supernatant liquor of which is drawn off by two cocks placed one above the other; after which the colouring particles, then in a state of semi-fluidity, are drawn off by a third cock into a linen strainer in the shape of a jelly-bag; and when they are reduced to the consistence of a paste, they are turned out into square

[a] Bibliotheque medico-physique du Nord. tom. iii.

boxes,

boxes, placed in the open air, under ſheds which ſhelter them from the ſun.

The indigo produced in theſe operations differs, not only according to the quality of the plant which afforded it, but according to the care employed in its preparation. Its colouring part however, appears to be invariably the ſame; ſo that the difference of its quality is entirely owing to the heterogeneous ſubſtances mixed with it, and the degree of conſiſtence which it acquired in dyeing.

There is a light ſort that comes from Guatimala, of a fine blue colour, and called *light indigo*, or *flower indigo* (indigo flore). It ſwims on water, whilſt all the other kinds ſink in it. This ſort is the fineſt and moſt valuable. There is a ſort known by the name of *coppery indigo*, becauſe its ſurface aſſumes a copper colour when rubbed againſt a hard body; and there are other ſorts much leſs pure, as that which comes from Carolina.

In the experiments of Bergman [b], one part in nine of indigo was found to be ſoluble in water by boiling. This part appeared to conſiſt of mucilaginous, aſtringent, and ſaponaceous particles. The aſtringent particles are

[b] Chemical analyſis and examination of indigo.

precipitable

precipitable by ſolutions of alum, of ſulphat of iron, and of copper.

Mr. Quatremere [c] alſo has ſeparated the ſoluble parts by means of water. He aſſerts, that their quantity is greater in proportion as the indigo is inferior in quality; and that the reſiduum, after this operation, is equal to the fineſt indigo: whence he propoſes, to purify indigo of inferior quality, by boiling it in a bag, renewing the water till it will take no more colour. Unqueſtionably this operation would be of advantage, as it would deprive the indigo of the yellow matter capable of altering its colour: ſtill however, its quality might differ, on account of the earthy particles not ſoluble in water, which it is true, could not affect its colour, but would vary the proportion of the colouring matter.

Powdered indigo digeſted in alcohol gave a tincture at firſt yellow, then red, and at laſt brown. By this operation ſeveral times repeated, it loſt about a ſeventeenth of its weight. From this tincture water ſeparated a browniſh reſinous ſubſtance.

[c] Analyſe & examen. chym. de l'indigo, tel qu'il eſt dans le commerce pour l'uſage de la teinture.

Ether acts on indigo nearly in the same manner as alcohol; but oils, either fixed or volatile, have little action on it.

Bergman mixed one part of indigo finely powdered, with eight parts of colourless sulphuric acid, so concentrated, that its specific gravity was to that of distilled water, as 1900 to 1000. The glass vessel in which these were mixed was slightly stopped. The acid attacked the indigo readily, and excited great heat. After twenty-four hours digestion, the indigo was dissolved, but the mixture was opake and black: by the addition of water it was rendered clear, passing successively through the various shades of blue, in proportion to the quantity of water. At least twenty pounds of water are required to render the smallest drop of the solution imperceptible, in a cylindrical glass vessel of seven inches diameter.

If the sulphuric acid be diluted with water, it attacks only the earthy principle mixed with the indigo, and some mucilaginous particles.

Several bottles in which a drop of this solution was mixed with liquors containing different substances, as acids, alkalis, and neutral salts, were exposed for some time to a temperature of from fifteen degrees to twenty degrees (65 to 77 Farh). In some the colour remained

unaltered; in others it became green, and was deſtroyed more or leſs readily. Bergman accounted for the changes he obſerved, by the property ſome ſubſtances poſſeſs of taking away phlogiſton, and others of affording it: but they may be happily explained by the attractions of oxygen, which ſome ſubſtances yield, or take away, or acquire from the atmoſphere.

Fixed alkalis ſaturated with carbonic acid ſeparate from the ſolution of indigo a very fine blue powder, which is depoſited very ſlowly. Bergman diſtinguiſhes this blue powder by the appellation of *precipitated indigo.* It may be obtained alſo by dropping the ſolution into alcohol, or into ſaturated ſolutions of alum, ſulphat of ſoda, or other ſalts containing the ſulphuric acid, but the liquor remains always in ſome degree coloured.

Concentrated nitric acid attacks indigo with ſuch violence as to ſet it on fire. If it be diluted to a proper degree, it acts with leſs vehemence, the colour of the indigo becomes ruſty, and the reſiduum, which amounts only to one third of the indigo employed, has the appearance of umber. Fixed alkali precipitates from the nitric acid which has acted on the indigo, a little oxyd of iron, mixed with barytes and

and calcareous earth: but if too much alkali be added, a part of the precipitate is rediſſolved, and the colour of the liquor becomes deeper than before.

Bergman ſays, that the nitrous acid which has been *phlogiſticated* by indigo, and has at the ſame time taken up a portion of its mucilage, may be employed for dyeing wool or ſilk of different ſhades, of a very permanent yellow: but here that great chemiſt miſtakes for a particular effect, the action always exerted by nitric acid on wool or ſilk, to which it gives a yellow colour, more or leſs deep according to its degree of concentration, and which he has himſelf deſcribed in his notes on Scheffer's eſſay on dyeing.

Mr. Hauſſman has given a more regular ſeries of obſervations on the changes produced in indigo by nitric acid, in an intereſting diſſertation [d], inſerted in the Journal de Phyſique for March 1788. After all the indigo which he had expoſed to the action of that acid appeared to be deſtroyed, he found in the veſſel a coagulum, which, being perfectly freed from nitric acid by waſhing, formed a brown viſcous maſs, having all the appearance of a gummy

[d] Sur l'Indigo & ſes diſſolvants.

refinous fubftance: it was foluble in alcohol, which indigo is not, and was not foluble in water, except in a large quantity, though more fo in hot water than in cold: and it was very bitter to the tafte. The water with which the coagulum had been wafhed, yielded on evaporation fmall cryftals, which exhibited many properties of the tartarous and oxalic acids, but the nature of which our author did not precifely afcertain.

Muriatic acid, digefted and even boiled on indigo, takes up the earthy part, the iron, and a little extractive matter, which colours it of a yellowifh brown, but has not the leaft action on the blue colour. If the indigo be precipitated from fulphuric acid, the muriatic acid will readily diffolve a certain portion of it, and form a deep blue liquor.

The other acids, as the tartarous, formic, acetous, and phofphoric, act on indigo like the muriatic: they diffolve precipitated indigo very well. Sulphuric acid too much diluted with water to diffolve indigo, and nitric acid alfo when too weak to decompofe it, diffolve only the earthy part and the extractive matter, which are altogether foreign to the colouring fubftance.

The

The oxygenated muriatic acid ſhews little action on indigo in ſubſtance, but deſtroys its colour when in a ſtate of ſolution. I employed the ſolution in ſulphuric acid to aſcertain the alterations it would induce in it. With this I mixed oxygenated muriatic acid, till its blue colour was entirely deſtroyed: it was then of a brown yellow. In this ſtate I evaporated it, and a blackiſh viſcous ſubſtance was gradually depoſited, which appeared to be of the ſame nature as that Mr. Hauſſman obtained by means of the nitric acid.

This effect of the oxygenated muriatic acid on the ſolution of indigo in ſulphuric acid, affords a very accurate method of determining the goodneſs of indigo. All the colouring particles contained in it are ſoluble in the ſulphuric acid, and form perfectly ſimilar ſolutions, for there is no difference between the colouring particles. The relative quantities therefore, of theſe particles contained in different ſpecimens of indigo may be found, by the proportions of oxygenated muriatic acid required to deſtroy the colouring particles extracted by ſulphuric acid from equal weights. In the ſecond ſection of the firſt part of this work, I have mentioned the precautions neceſſary in making this experiment.

Pure or cauſtic fixed alkali diſſolves ſome ſubſtances foreign to the colouring matter of indigo, but acts little on the colouring matter itſelf. Cauſtic volatile alkali or ammoniac, acts nearly in the ſame manner. Precipitated indigo diſſolves readily without heat, in alkalis, fixed or volatile. If they be pure or cauſtic, the blue colour changes gradually to a green, and is at length deſtroyed: but if they be combined with carbonic acid the colour is not altered. Lime-water has little action on indigo itſelf, but it diſſolves precipitated indigo. This ſolution changes its colour, which is ultimately deſtroyed, nearly in the ſame manner as thoſe in cauſtic alkalis.

Indigo expoſed to the action of fire in an open crucible, or under a muffle, fumes, ſwells, grows red, and ſometimes takes fire, emitting a white flame. A hundred parts of indigo leave thirty-three or thirty-four parts of aſhes.

Theſe aſhes afford no fixed alkali when lixiviated with diſtilled water. Muriatic acid diſſolves the greater part of them with a ſlight effervefcence: the reſiduum, which is inſoluble, conſtitutes an eleventh part, and has the characters of ſiliceous earth.

The ſolution in muriatic acid produces pruſſian blue, on mixing with it pruſſiat of pot-aſh.

From

From thirty to thirty-two grains (25 to 27 English) are obtained from the ounce of indigo. Bergman concluded that the ounce contained eighteen or twenty grains (15 or 16) of iron: but he has aſcertained in various ſubſequent works, that pruſſian blue formed by means of pruſſiat of pot-aſh, contained only about a ſixth of its weight of iron; ſo that from the above experiment we ſhould reckon only five or ſix grains (4 or 5) in the ounce.

Beſide the iron and ſiliceous earth, the aſhes contain calcareous earth and barytes.

Indigo detonates ſtrongly with nitre. In diſtillation it affords carbonic acid, a liquor containing a little volatile alkali, and an oil reſembling the empyreumatic oil of tobacco, and readily ſoluble in alcohol.

Bergman concludes from his analyſis, that a hundred parts of good indigo contain,

Mucilaginous matter ſeparable by means of water	12
Reſinous matter ſoluble in alcohol	6
Earthy matter ſoluble in acetous acid, which does not attack the iron here in the ſtate of oxyd	22
Oxyd of iron ſoluble in muriatic acid	13

 The

The forty-feven parts remaining are almoft pure colouring matter, which, diftilled alone, affords

Carbonic acid	2
Alkaline liquor	8
Empyreumatic oil	9
Coal	23

The coal burnt in the open air, gave four parts of earth, about half of which was oxydated iron, and the remainder a very fine filiceous powder.

From thefe refults, that great chemift confiders indigo as a fubftance analagous to pruffian blue, and the colouring parts of ink. He thinks that, like thofe fubftances, it owes its colour to iron: but it has been fhewn that the method ufed by him to calculate the iron contained in it, exaggerated its quantity. Befides, we fhould reckon only that iron which enters into the compofition of the colouring matter; for that which the muriatic acid can diffolve without attacking the colouring matter, ought to be confidered as a foreign fubftance, as well as the earths and extractive and refinous matters, the quantities of which vary greatly in different kinds of indigo. Now from forty-feven parts of pure indigo, Bergman obtained only two parts of oxyd of iron, which owes at

leaft



leaſt a fourth of its weight to oxygen. Hence it follows, that iron cannot be reckoned more than a thirtieth part in the compoſition of the colouring matter of indigo, the properties of which, moreover, appear to have but a very ſlight relation to thoſe of pruſſian blue, and the colouring parts of ink. Iron then, can have but little influence in producing the colour of indigo.

It is known at preſent that moſt of the principles obtained by diſtillation, as oil, carbonic acid, and ammoniac, did not exiſt in the ſubſtance from which they are diſengaged by heat; but that they are new combinations, owing to principles, which, by their union, formed the original ſubſtance. Thus there is neither oil, nor ammoniac, in indigo: but from the products of its analyſis we may conclude, that it contains a pretty conſiderable quantity of hydrogen, a little azot, a very ſmall quantity of iron, but above all, ſuch a proportion of coal as is obtainable from no other known vegetable ſubſtance, ſince forty-ſeven grains of pure indigo left twenty-three of coal, from which, it is true, we are to ſubtract four grains of aſhes, but then on the other hand, we muſt add the coaly matter contained in the oil, in the carbonic acid, and in the carbonic hydrogenous

gas,

gas, which was no doubt disengaged in the operation. Other experiments will shew, that oxygen really exists in indigo, without forming such an intimate combination as when it enters into the composition of water. As to the siliceous earth, it does not appear whether it be a component part of the colouring matter, or simply mixed with it.

The great quantity of coal and of hydrogen which enter into the composition of indigo, account for its prompt inflammability, and the brisk detonation it produces with nitre. The nitric and oxygenated muriatic acids appear to me to produce the blackish viscous substance before mentioned, by forming water from a combination of their oxygen with the greater part of the hydrogen of the indigo, so that the coaly matter remains combined with only a very small portion of hydrogen.

In the first part of this work I have exhibited the reasons which to me seem to prove, that the fixity and unchangeableness of colours are chiefly owing to the proportion of fixed principles which enter into the composition of the colouring matter, and the abundance of coal, which, combining with oxygen less readily than hydrogen does, gives them the property of resisting the action of the air.

In

In indigo we find this abundance of coal which muſt render its colour fixed and unchangeable. Forty-ſeven parts of pure indigo left on diſtillation twenty-three of coal, in Bergman's experiments: and Mr. Quatremere ſays, that four ounces of indigo yielded him two ounces and a half of coal. If we turn our attention to the preparation by which it is extracted, or rather formed, it appears, that the ſubſtance to which it owes its origin muſt have been of a reſinous nature when in the organized plant: that in the preparation it has undergone, in the kind of putrefaction it has experienced, a part of its hydrogen has been conſumed by a ſlow combuſtion, during which a gas eſcaped: and that the chief uſe of the beating was to favour the contact and action of the air. This theory is confirmed by the circumſtances which accompany the beating: if it be continued too long, the indigo is changed, blackened, and *becomes what is called burnt indigo* [e].

Indigo has not indeed the brown or fawn colour, which moſt commonly indicates that combuſtion of which I have laid down the theory: but I have remarked, that this colour

[e] Hiſt. philoſ. & polit. des établ. &c. livre vi.

is

is not an inſeparable effect of it, for colours are influenced by ſlight circumſtances: beſides, a deep blue approaches conſiderably the proper colour of coal.

I have advanced, that when colouring matter like that of flax underwent a ſlight combuſtion, a ſmall portion of oxygen remained united with it, without combining particularly either with the hydrogen or with the coal, and that hence aroſe ſome of its qualities. It appears, that we find in indigo this property, which remains to be examined; and from this it is, that the putrefaction, or rather combuſtion, which it undergoes in its preparation, muſt have a certain limit, which if exceeded, the indigo is rendered of bad quality.

It has been ſeen that indigo is not naturally ſoluble, either by alkalis or lime, yet in the proceſſes employed, it is diſſolved by thoſe ſubſtances, from which it is afterwards precipitated on the matter to be dyed. The ſolution of indigo by lime or alkali is greeniſh. At the ſurface it becomes blue, becauſe there the indigo is precipitated in its natural ſtate. The green colour is not produced by the alkalis, as it is in many other blue vegetable ſubſtances, as Bergman obſerves: for theſe, when rendered green, recover their colour as ſoon as the

alkali is ſaturated with an acid, which of itſelf would give them a red colour: but an alteration of the colouring matter of indigo was requiſite to its ſolution in an alkali, and acids have not the property of making it red. It remains to inquire what change the indigo experiences previous to its ſolution in alkalis.

Bergman examines two proceſſes, to deduce from them the cauſe of the changes produced in the indigo. When we treat of theſe as operations of the dyer, we ſhall conſider them more minutely: at preſent it is ſufficient merely to mention them. If ſulphat of iron be mixed in water with an equal weight of indigo, and double its weight of lime, the indigo ſoon diſſolves: but Bergman has obſerved, that if the ſulphat of iron be boiled for ſome hours in a large portion of water, afterwards reduced to a proper quantity by evaporation, the ſolution would not take place. If a ſolution of pure or cauſtic fixed alkali be taken, and to this indigo and ſulphuret of arſenic or orpiment be added, the bath ſoon becomes green, and the indigo is diſſolved. If inſtead of the ſulphuret of arſenic, we ſubſtitute the portion of arſenic it contains, the bath will never be fit for dyeing; but on adding the quantity of ſulphur it

ought

ought to contain, we ſhall ſoon ſee marks of ſolution.

Bergman attributes theſe effects to phlogiſton, communicated to the indigo in the firſt inſtance by the precipitate of iron, in the ſecond by the orpiment, by means of which it is rendered ſoluble by the alkali and the lime; ſo that when the precipitate of iron has been deprived of its phlogiſton by a long ebullition, it is unable to occaſion a ſolution of the indigo, becauſe it is no longer capable of affording it phlogiſton.

In this explanation we have only to make thoſe alterations which are pointed out by the improvements made in phyſics. Indigo contains a portion of oxygen, which may be taken from it by ſubſtances that have a ſtrong attraction for it, and then it becomes ſoluble by lime and alkalis. The freſh precipitate of ſulphat of iron is a ſubſtance of this kind: for it is known from the experiments of Dr. Prieſtly, that this precipitate combines with vital air with which it is placed in contact, whilſt its green colour changes to a red, and then to a yellow; but by a long ebullition the iron combines with more and more oxygen, and at length becomes ſaturated with it, thus being rendered incapable of taking it from the indigo.

digo. Sulphuret of arſenic alſo, when diſſolved in an alkali, has a ſtrong attraction for oxygen; but the oxyd of arſenic has a very ſlight tendency to combine with that principle.

Mr. Hauſſman has proved by a direct experiment, that the ſolution of ſulphuret of arſenic mixed with indigo abſorbed vital air, with which it was in contact: for having put ſome of that ſolution, known in the dye-houſe by the name of *printing blue* (bleu d'application) in contact with air obtained by diſtilling nitre, ſeven eights of the air were abſorbed, and the reſiduum was found to be azotic gas. The printing blue was entirely ſpoilt, and the indigo was regenerated: a portion of the alkali united with the ſulphuric acid produced, and formed with it ſulphat of pot-aſh: there remained ſome cauſtic alkali, and the arſenic, inſtead of being in the metallic ſtate, as it is in the ſulphuret of arſenic, was combined with it in the ſtate of oxyd. Perhaps Mr. Hauſſman would have found, that a part of the arſenic was in the ſtate of an acid, had he purſued his inquiries with more accuracy.

Though with reſpect to the theory of this obſervation, Mr. Hauſſman remains undecided whether to adopt the phlogiſtic hypotheſis, or the natural explanation which attributes the

phenomena

phenomena juſt deſcribed, to the abſorption of air and the combination of oxygen, no doubts of the validity of the latter can remain at preſent, when it is known that the air obtained from nitre is compoſed of vital air, and a more or leſs conſiderable proportion of azotic gas or phlogiſticated air, according to the degree to which the decompoſition of the nitre has been carried. The azotic gas, which Mr. Hauſſman found as a reſiduum, was preexiſtent then, and had no ſhare in producing the phenomenon: the vital air was ſimply abſorbed by the ſulphur, which was converted into ſulphuric acid: it combined alſo with the arſenic, reducing it to the ſtate of oxyd, and perhaps even of an acid; while a portion of it united likewiſe with the indigo diſſolved by the cauſtic alkali: hence the indigo reſumed its blue colour, and its natural ſtate; the cauſtic alkali was no longer capable of acting on it; and it was precipitated: circumſtances perfectly analogous to thoſe which take place in the ſolution of indigo produced by means of ſulphat of iron.

It follows from what has been ſaid, 1ſt, that indigo in its natural ſtate contains oxygen: 2dly, that while it retains this oxygen it is incapable of uniting with alkalis or lime: 3dly, that

that ſubſtances capable of depriving it of this portion of oxygen render it ſoluble by lime and alkalis: 4thly, that this ſolution is decompoſed, and the indigo reſumes its natural ſtate, when it comes into contact with atmoſpheric air, and attracts the oxygen of which it had been deprived. The very ſame things happen when any ſubſtance is dyed in the indigo vat. In the vat it acquires a green colour; but when it is expoſed to the air it becomes blue, becauſe the indigo recombines with the oxygen it attracts from the atmoſphere, by which it is reſtored to its natural ſtate, and the lime or alkali is ſet at liberty: the latter being carried off in the waſhing, the indigo remains combined with the ſubſtance, which is found to be dyed by its means. I have found, that a pattern of cloth, or cotton, coming green out of the vat, acquired in like manner a blue colour, by dipping it quickly into oxygenated muriatic acid, ſufficiently diluted not to decompoſe the indigo.

With reſpect to Mr. Hauſſman's experiment I ſhall obſerve, that the ſulphuret of alkali and of arſenic acts much more powerfully on oxygen than the ſimple ſulphuret of alkali; which may be owing to two cauſes: 1ſt, the arſenic, which in the ſulphuret of arſenic is in the me-

tallic ſtate, or very ſlightly oxydated, may itſelf act on the oxygen: or 2dly, the union of the ſulphur and alkali may not be ſo intimate in the triple compound of alkali, arſenic, and ſulphur, as in the more ſimple ſulphuret, compoſed of ſulphur and alkali only; ſo that the ſulphur exiſting in a ſtate of equal diviſion may act more ſtrongly on the oxygen.

However this may be, on the more powerful action exerted on oxygen by the ſulphur of alkali and of arſenic depends the more ſtriking effect it produces on wines that contain lead; becauſe it thereby reduces nearer to the metallic ſtate the oxyd of lead, which thence acquires a blacker colour.

It has been ſeen, that indigo underwent from the action of the nitric and oxygenated muriatic acids a combuſtion, in which its hydrogen was alone, or at leaſt principally, deſtroyed. Sulphuric acid in diſſolving it, appears alſo to produce a ſlight combuſtion, which is perceived by the ſmell of ſulphureous acid, however gentle the heat by which the ſolution is effected. If the heat employed be a little too great, the ſigns of combuſtion are very evident. To this alteration I attribute the changes obſerved by Bergman in the indigo precipitated from ſulphuric acid. Thus, pure alkali and lime diſ-

ſolve

ſolve the precipitate, render it green, and ſoon deſtroy its colour, ſo as not to be recoverable by acids, becauſe, as I have ſhewn, they favour the progreſs of the combuſtion. If the liquor which is deprived of its colour were evaporated, a reſiduum of the nature of that left by the nitric and oxygenated muriatic acids would probably be obtained.

Indigo, when it has undergone a ſlight alteration from the ſulphuric acid, does not adhere ſo ſtrongly to wool or ſilk, as when it is in its natural ſtate. Hence the *ſaxon blue*, produced by a ſolution in ſulphuric acid, is leſs permanent than the blue of the indigo vat; and that ſolution is capable of giving only a ſlight dye to ſilk, and a ſtill ſlighter to thread or cotton.

If we attend to the properties acquired by indigo when deprived of a portion of its hydrogen, as it is by the oxygenated muriatic acid, it will not be difficult to explain the greater part of the obſervations made by Bergman on different mixtures with ſolution of indigo.

Mr. Hauſſman has obſerved, that the ſulphuret of antimony, or crude antimony, promoted the ſolution of indigo, in the ſame manner as ſulphuret of arſenic; but that the oxyd of antimony mixed with ſulphur would not

produce the ſame effect. He remarked, that the ſolution of indigo by means of ſulphuret of antimony could not be uſed as a printing blue, *couleur d'application*, becauſe the antimony was precipitated in a red ſtate, probably remaining combined with a little ſulphur. Other metallic ſulphurets did not ſucceed with him; becauſe, as he obſerves, they are not ſoluble in cauſtic alkali.

We are indebted to Mr. Hauſſman for many other intereſting obſervations, which I am not yet able to explain in a ſatisfactory manner. He digeſted a mixture of iron filings reduced to a fine powder, indigo ground with water, and concentrated cauſtic alkaline liquor, without being able to diſſolve the colouring ſubſtance: but a very good ſolution was procured by means of antimony in its metallic ſtate. The oxyds of antimony appeared to have no action on it; and zinc, though it acts ſtrongly on oxygen, produced no ſolution.

The precipitate of copper with indigo exhibited to him ſome peculiar phenomena. Far from contributing to its ſolution, it effected its regeneration from all the different arſenical and antimonial ſolutions, as well as from that obtained by means of precipitate of iron. The ſolution of copper in ammoniac produces the ſame

ſame effect. He ſays, that the dyers avail themſelves of this property of copper, more readily to exhauſt the blue vats, which, from having been too long in uſe, or containing originally too little indigo, give but very weak ſhades; but on dipping the goods to be dyed into a water very ſlightly impregnated with ſulphat of copper, or other coppery ſolution, whether acid or alkaline, deeper ſhades are obtained.

CHAP. II.

Of Paſtel and Woad.

PASTEL is a plant of the family of the cruciferæ, the diſtinguiſhing character of which is taken from the form of the ſeed-pod, which is flat like that of the aſh, edged with a thin membrane, and contains two long ſeeds. Two ſpecies are diſtinguiſhed: that which is cultivated, *iſatis tinctoria*, *Lin.* and the portugueſe paſtel, *iſatis Luſitanica*, *Lin.* which differs from the former in being ſmaller and having a narrower leaf. The former ſpecies puts

out ſtalks three feet high, of the thickneſs of a man's finger, which divide into a number of branches, abounding with large lanceolated leaves, of a blueiſh green colour, the margins of which have little ſmooth indentations. The flowers are yellow, diſpoſed in panicles on the ſummits of the ſtalks. The root is large, woody, and penetrates deep into the earth.

This plant requires a good black earth, light, and well manured. It is ſown in February, March, or April, after two ploughings in autumn. It affords three or four crops a year: the firſt when the ſtalks begin to grow yellow, and the flowers are ready to appear; the others at intervals of ſix weeks, or more, according to the climate and warmth of the ſeaſon.

The plant is mown, waſhed afterwards in a river, and dried in the ſun. Care muſt be taken, that it dry ſpeedily; for if the ſeaſon be unfavourable, or it ſhould rain, the plant is in danger of being ſpoiled: one night is ſometimes ſufficient to turn it black.

The plant is next carried to the mill to be ground, and reduced to a paſte. Of this are formed heaps, which are covered ſo as to ſecure them from rain. At the end of a fortnight the paſtel heap is opened, and beaten ſo as to mix the cruſt formed on the ſurface with the

inner part. It is then made into round balls, which are carried to a place expofed to the wind and fun, that they may be deprived of their moifture, which would render them liable to putrify. Thefe balls, heaped upon one another, grow hot by infenfible degrees, and exhale a fmell of volatile alkali, which is ftronger in proportion as the quantity is larger, and the feafon warmer. The heat that has commenced is increafed by watering the heap flightly, till the paftel is reduced to a coarfe powder. It is in this ftate we find it in commerce.

Paftel is cultivated and prepared chiefly in Languedoc, Provence, and Normandy. That of Languedoc is moft efteemed. In Normandy it bears the name of woad, differing from the common paftel only in requiring a larger quantity to produce the fame effect, as Hellot has experienced.

Paftel gives, without indigo, a blue colour, which has no luftre, but is very permanent. As it affords much lefs colouring matter than indigo, and as its colour is inferior in beauty, the difcovery of indigo has greatly diminifhed the cultivation and fale of paftel.

Aftruc fays, in his Memoirs on the Natural Hiftory of Languedoc, that on treating paftel in fmall quantity, in the fame manner as anil

is treated for obtaining indigo, he procured from it a powder which produced the ſame effects as indigo does. From this Hellot has concluded, that the deep green colour of many plants is owing to blue and yellow particles, and that if we could deſtroy the yellow by fermentation, the blue would remain. But Lewis ſays [a], that having cauſed herbs of different kinds to putrefy in water, he obtained no blue feculæ. I have already obſerved, that the ſuppoſition of a mixture of blue and yellow particles to form the green of plants, is deſtitute of foundation.

It appears, that the ſcheme of extracting indigo from paſtel has been carried into execution in Germany. Mr. Gren thus deſcribes the proceſs employed [b]. Freſh leaves of paſtel are waſhed in an oblong vat, nearly three parts filled, to cleanſe them from the earth and filth: to prevent the water from raiſing them up, they are kept down with croſs pieces of wood: on theſe leaves a ſufficient quantity of pure water to cover them completly is poured, and the veſſel is placed in a moderate heat: in a

[a] The chemical works of Caſpar Neumann, by William Lewis.

[b] *Crell's neueſte Entdeckungen.* A french tranſlation is to be found in the *Bibliotheque medico-phyſiqua du Nord*, tom. iii.

longer

longer or ſhorter time, according to the temperature of the atmoſphere, a plentiful ſcum forms on the ſurface of the water, which indicates the commencement of the fermentation. By degrees the ſurface becomes covered with a blue pellicle, preſenting to the eye tinges of a coppery hue. When there is a certain quantity of this ſcum, the liquor, which is of a deep green colour, is drawn off into another oblong vat, by means of a cock placed juſt above the bottom, or it is laded out to be put into the other vat. In either caſe it is neceſſary to paſs it through a cloth, to ſeparate the impurities, or bits of leaves, which might otherwiſe be mixed with it. The leaves are then waſhed with cold water, to remove any portion of the coloured pellicle which may adhere to them, and this water is mixed with that before drawn off. After this, lime-water is poured into the fermented paſtel liquor, in the proportion of two or three pints to every ten pounds of leaves, and the liquor is ſtirred briſkly for ſome time, to facilitate the ſeparation of the indigo, which is depoſited by ſtanding. To know whether the ſtirring has been continued long enough, a little of the clear yellowiſh liquor is put into a common bottle, and ſhaken ſtrongly: if any blue matter

ſeparate

ſeparate from it, the liquor muſt be again ſtirred. When all the indigo is ſeparated, and has fallen to the bottom, the clear water is drawn off through a cock placed a little above the bottom of the vat, or by means of a ſiphon. This ſhould be done without loſs of time. To facilitate the ſeparation of the water, the vat may be inclined towards the cock, as ſoon as the ſtirring is finiſhed. The blue colour which remains is put into conical filters of linen, or Hippocrates ſleeves. As a little of the colour always runs through theſe at firſt, the liquor ſhould be received in a veſſel placed beneath, and returned into the filter, till the water comes off clear. The indigo contained in the filters is to be edulcorated with a ſufficient quantity of water, and dried in the ſhade, or with a gentle artificial heat, taking care to keep it covered.

Indigo may be obtained without the addition of lime-water, but not in ſo large a quantity. If a greater portion of lime-water be uſed, the quantity of the indigo will be increaſed, but its quality will be inferior, becauſe the ſurplus of calcareous earth will unite with it. Alkaline ſalts likewiſe facilitate the ſeparation of the blue colour: but it would not be advantageous employ them, becauſe they afterwards diſ-

ſolve

ſolve a part of it. No precipitate is occaſioned by the addition of an acid.

It is neceſſary that a certain time be ſuffered to elapſe, before the water which has fermented with the paſtel leaves is drawn off. If it be drawn off too ſoon, little indigo will be obtained: if the leaves be left too long in infuſion in the water, they readily enter into a ſtate of putrefaction, emit a peculiar putrid and volatile ſmell, and the precipitate is no longer ſeparable, the water remaining conſtantly green. It is the ſame with the water drawn off, if it be neglected; and even when the indigo is already ſeparated from the liquor, care muſt be taken to prevent it from running into putrefaction, which would occaſion the loſs of the whole, or at leaſt, part of the indigo.

We muſt not however, be too haſty in turning the water into the vat in which it is to be ſtirred, at the firſt appearance of the changeable blue pellicle, ſince that is the time when it is acquiring moſt indigo.

When the heat of the atmoſphere is conſiderable, the fermentation takes place very readily, and from fifteen to eighteen hours are frequently ſufficient. Under ſuch circumſtances we muſt be particularly attentive not to ſuffer it to go on to a complete putrefaction. If the heat

heat of the atmofphere be too flight, no great quantity of fcum, or of the blue pellicle, will be perceived, but the liquor will infenfibly incline to putrefaction, without exhibiting any very decifive marks of it previous to its commencement.

The plant bruifed, or its juice, ferments more fpeedily, but affords only a dull blue.

The indigo obtained from paftel muft be dried in the fhade, becaufe the fun deftroys its colour.

Mr. d'Ambourney, who appears not to have been acquainted with the preceding experiments, has alfo fought methods of making indigo from paftel [c]. He fucceeded by letting frefh leaves of paftel ferment in a certain quantity of water; taking out the leaves, and pouring folution of cauftic alkali into the liquor; and afterwards filtering. The fecula remaining on the filter he compared to Carolina indigo. Thirty-five pounds of frefh ripe paftel leaves afforded him eight ounces of fecula.

[c] Supplément au Recueil des procédés d'expériences, &c.

CHAP.

CHAP. III.

Of Dyeing in the Blue Vat with Indigo, and with Paſtel.

DIFFERENT proceſſes are employed for dyeing blue by means of indigo. Theſe I ſhall briefly mention, without entering minutely into the particulars, which are well known in the dye-houſe, and moſt of which are carefully deſcribed in the work of Hellot.

The preparation for dyeing blue is not made in a copper, like thoſe for other colours, but in a large wooden veſſel called a vat. This is ſunk into the ground ſo as to be only breaſt high above it. As it is of moment to preſerve the heat of the vat, it is not fixed in the ſame place as the coppers, which require a free circulation of air, but in a place adjoining, conſtructed in ſuch a manner as to retain the heat. This place is called *gueſdre*; and the men that work the vat, who ought to be inſtructed by long experience to prevent the accidents to which it is liable, are called *gueſdrons*.

Blue may be dyed with paftel or woad; which would give a permanent, though not deep blue; affording only a fmall quantity of colouring matter, as has been faid in treating of thofe fubftances. But if indigo be mixed with them, vats will be obtained very rich in colour; and thefe are almoft the only ones ufed for wool or woollens. They are diftinguifhed by the name of paftel vats.

Hellot has not accurately determined the proportions of the fubftances employed: I fhall therefore borrow my defcription of a vat of this kind from Mr. Quatremere. It is to be obferved however, that the proportions vary, not only in different dye-houfes, but according to the fhades required.

Into a vat of feven feet (French) deep, and five in diameter, are thrown two balls of paftel, weighing together four hundred pounds, firft breaking them.

Thirty pounds of weld are boiled in a copper for three hours, in a fufficient quantity of water to fill the vat. When this decoction is made, twenty pounds of madder, and a bafket full of bran are added, and it is boiled half an hour longer. This bath is cooled with twenty buckets of water, and after it is fettled, the weld is taken out, and it is poured into the

vat.

vat. All the time it is running in, and for a quarter of an hour after, it is to be ſtirred with the rake.

This being done, the vat is covered up very hot, and let ſtand ſix hours, when it is uncovered, and raked again for half an hour. This operation is repeated every three hours.

When blue veins are perceived on the ſurface of the vat, what is called *its ground* is given it, that is, eight or nine pounds of quick-lime. As ſoon as this ſubſtance is put in, new appearances are perceived: the colour of the vat becomes a blacker and deeper blue, and its exhalations more acrid.

Immediately after the lime, or at the ſame time with it, the indigo is put into the vat, being firſt ground in a mill with the leaſt poſſible quantity of water. When it is diluted to the conſiſtence of thick pap, it is drawn off through a cock at the lower part of the mill, and thrown into the vat without any further preparation. The quantity of indigo to be uſed, depends on the ſhade to which the wool or cloth is to be brought: from ten to thirty pounds may be put into a vat compoſed in the proportions above mentioned, without the leaſt inconvenience.

If on ſtriking the vat with the rake, a fine blue ſcum called flower *(fleurée)* be obtained, nothing more is requiſite previous to dyeing, than to ſtir it with the rake twice in the ſpace of ſix hours, that the ingredients may be thoroughly mixed. Sometimes it is neceſſary to add a little lime.

The bath when firſt poured on the paſtel is boiling hot; and care is taken not to leave the vat expoſed to the air, except the time neceſſary for ſtirring it. As ſoon as that operation is over the vat is covered with a large wooden lid, on which thick cloths are ſpread, and every method of preſerving its heat, without the aſſiſtance of fire is employed. Notwithſtanding theſe precautions, however, favoured too by the conſtruction of the *gueſdres*, the heat can be kept up for a certain time only. At the end of eight or ten days it is greatly leſſened: and will at length be entirely diſſipated, if the liquor be not reheated.

This operation conſiſts in pouring the greater part of the liquor of the vat into a copper, under which a large fire is made. When this bath is ſufficiently hot, it is returned into the vat as before, and carefully covered.

The paſtel vat is liable chiefly to two accidents. In the one it becomes *repelled*

(roide,

(roide, ou rebutée) in the language of the *guesdrons*. This is found to be the case, when on uncovering a vat that has already afforded fine shades of blue, it appears black, without any blue veins, without flower *(fleurée)*: if it be stirred, the black colour grows deeper and deeper, and the smell, instead of being somewhat sweetish, as it is when the vat is in a proper state, affects the nose with a very pungent odour. If an attempt be made to dye with a vat exhibiting these marks, the stuff takes no colour, or comes out of a dirty gray. These bad qualities are owing to an excess of lime; and Mr. Quatremere says, that he has imparted them to a vat, by putting too much lime into it.

The *guesdrons* employ different means to recover a repelled vat. Some put into it tartar, bran, urine, or madder: others content themselves with reheating it. The best remedy, according to Hellot, is to put in bran and madder at discretion. If it have but a little too much lime, it is sufficient to leave it at rest five or six hours or more, putting in only a certain quantity of bran, and three or four pounds of madder, which are to be sprinkled on the surface, when it is to be covered, and tried after a due interval. If it be repelled to

 such

ſuch a degree as not to give a blue but when it is cold, it muſt be left to recover without diſturbance; and ſometimes it muſt remain whole days without being ſtirred with the rake. When it begins to afford a tolerable pattern, the bath muſt be reheated. In general this revives the fermentation: or it may be excited with bran and madder, or even with a baſket or two of freſh paſtel.

Meſſieurs d'Orval and Ribeaucourt[a] adviſe, merely to let the vat reſt without raking, if it be but ſlightly repelled: but if it be ſo in a conſiderable degree, to put in a few pounds of bran encloſed in a bag, at the ſame time ſprinkling in three or four pounds of powdered tartar. In five or ſix hours the bag, which riſes to the top, is to be taken out, and the vat raked. If it be not yet recovered the proceſs is to be repeated.

Mr. Quatremere ſays, that to recover a vat, which he had repelled by overloading it with lime, he contented himſelf with reheating it twice, leaving it at reſt afterwards two days, when it gave a well-marked flower. After this he let it ſtand three days, reheated it a third time, and found it to be recovered.

[a] Mémoire ſur l'indigo, tel qu'il eſt dans le commerce, pour l'uſage de la teinture.

The

The ſecond accident to which the paſtel vat is liable is putrefaction. When this happens, the veins and flower diſappear, the colour of the vat becomes ruddy, the paſte riſes from the bottom, and a fetid ſmell is emitted.

Mr. Quatremere aſſerts, that a pattern of a deep blue plunged into a vat in this ſtate, becomes ſeveral ſhades lighter. Putrefaction takes place in the vat becauſe it has not been ſufficiently ſupplied with lime. As ſoon as ſigns of putrefaction appear, we ſhould haſten to correct it, by adding lime and raking it. In two hours time more lime is to be put in, and the vat raked again; and theſe operations are to be repeated till it is recovered: but care muſt be taken not to run into the oppoſite exceſs.

It appears, that nothing requires ſo much attention in the management of a paſtel vat, as the diſtribution of the lime. In conſidering this vat alone, it would be difficult to determine what paſſes in it: but the experiments related when treating of indigo, ſhew, that to render that ſubſtance ſoluble by lime or alkalis, it muſt be deprived of the oxygen it contains. The paſtel in which putrefaction has commenced, and which is much diſpoſed to run into the true putrid ſtate, acts in two ways: it ſeizes

the oxygen of which the indigo is to be deprived, and at the ſame time affords a blue colouring matter analogous to indigo. But the putrefaction of this drug would take place with too much rapidity, if it were not reſtrained by the lime, which, as Pringle's experiments ſhew, has the property of reſiſting putrefaction. A principle uſe of the lime then, is to moderate the diſpoſition of the paſtel to putrefy, and to confine it to a ſtate of gentle fermentation, ſufficient to deprive the indigo of its oxygen, and to produce in the colouring matter of the paſtel that ſlight combuſtion which it muſt undergo, to acquire properties analogous to thoſe of indigo. Another uſe of the lime, or of one part of it, is to diſſolve the blue particles which are rendered ſoluble. If too much lime be put into the vat, the neceſſary fermentation is ſtopped, and it muſt be renewed, either by heat, or by fermentable ſubſtances, or by abſorbing the exceſs of lime by vegetable acids. If on the other hand, too little lime be put in, the paſtel runs into a true putrefaction, which would deſtroy the indigo, and which muſt be brought back to a due degree of fermentation, by repeatedly adding lime till it is reduced to the proper point.

Two

Two hours before dyeing, the vat is raked, and to prevent the ſediment, called paſte, *(patèe)* from occaſioning inequalities in the colour, a kind of lattice formed of large cords, termed a croſs *(champagne)* is introduced, and indeed when wool is to be dyed in the fleece; a net with ſmall meſhes is placed over this. The wool or cloth being thoroughly wetted with clear water a little warm, is preſſed out, and dipped into the vat, where it is moved about a larger or ſhorter time, according as the colour is required to be more or leſs deep, taking it out occaſionally to air. The action of the air is neceſſary to change the green colour given by the bath to a blue. In a rich bath it is difficult to give an uniform colour to light blues: the beſt method of obtaining ſuch ſhades, therefore, is to uſe vats already exhauſted, and which begin to grow cold.

Wool and cloth dyed blue ought to be waſhed with great care, to carry off the particles not fixed in the wool; and thoſe which are of a ſomewhat deep blue ought even to be carefully cleanſed by fulling with ſoap, which does not alter the colour. Thoſe deſigned to be dyed black ought to be treated in the ſame manner; but it is not ſo neceſſary for thoſe intended to be green.

A vat containing neither paſtel nor woad is called an *indigo vat (cuve d'Inde).* The veſſel uſed for this preparation [b] is a copper, which, being of a conical figure, leaves between it and the brick-work that ſurrounds it, and on which its brim reſts, an empty ſpace ſufficient for containing the fire. Into this copper are poured forty buckets of water, more or leſs, according to its capacity, in which have been boiled ſix pounds of *cendres gravelées,* twelve ounces of madder, and ſix pounds of bran. This liquor is to be put into the vat, grounds and all. Six pounds of indigo ground in water are then to be put in, and after raking it carefully, the vat is to be covered. A ſlow fire is to be kept up round it. Twelve hours after it is filled, it is to be raked a ſecond time; and ſo on every twelve hours, till it is come to or become blue, which it will be in forty-eight hours. If the bath be well managed, it will be of a fine green, covered with coppery ſcales, and a blue ſcum or flower.

The theory of this vat is the ſame as that of the foregoing, except that the indigo is here diſſolved by means of alkali inſtead of

[b] Mémoire ſur l'indigo, par M M. d'Orval & Ribaucourt.

lime.

lime. When this vat, which is much more eaſily managed than that of paſtel, is in a proper ſtate, it may be uſed for dyeing in the ſame manner as the preceding.

Hellot deſcribes two vats in which the indigo is diſſolved by means of urine. Madder is added to it, and in the one vinegar, in the other alum and tartar, of each a weight equal to that of the indigo. The quantity of urine ought to be very conſiderable. There is a probability, that the indigo, deprived of its oxygen by the urine and madder in fermentation, is diſſolved by the ammoniac, which is formed in the urine, either by the action of heat, or by putrefaction. Hellot remarks, that an efferveſcence takes place on pouring in the ſolution of alum and tartar, which probably tends to ſtop the putrefaction. Theſe vats are by no means comparable with that of paſtel, or that of indigo before deſcribed, much leſs work being expedited by them, ſo that they are adapted only to ſmall dye-houſes.

For dyeing ſilk blue, the indigo vat before deſcribed is uſed. In general a larger proportion of indigo is put in, than is there directed, but nearly the ſame quantities of bran and

madder. Macquer ſays [e], that if half a pound of madder be employed, for every pound of *cendres gravelées*, the vat becomes greener, and its colour is more fixed in the ſilk, without being of a leſs pleaſing caſt. The paſtel vat, and the others that have been deſcribed, are not proper for dyeing ſilk, becauſe they do not colour it with ſufficient readineſs.

When the vat is come to *(en état)* what is called a *brevet* is given it, with about two pounds of *cendres gravelées*, and three or four ounces of madder: it is then raked; and in four hours is ready for dyeing. The heat ought to be at that time moderated ſo that the hand may be held in it without pain.

Previous to its being dipped in this vat, the ſilk muſt be boiled with ſoap, in the proportion of thirty pounds of ſoap to a hundred of ſilk, and well cleanſed from it by two or more beetlings in a ſtream of water. As the ſilk is very liable to take an uneven colour, it is neceſſary to dye it in ſmall portions. Thus the workman dips each hank one after another, having firſt put it on a wooden cylinder; and when he has turned it once or oftener in the bath, he wrings it ſtrongly over it, and airs it,

[e] Art de la teinture en ſoie.

to

to turn the green colour to a blue. When the green appears thoroughly changed, he throws it into ſome clear water, after which he wrings it ſeveral times with the pin.

Care muſt be taken, that the ſilk dyed blue, dry ſpeedily. In the winter, and in damp weather, it ſhould be dried in a chamber heated by a ſtove, being hung on a kind of frame kept conſtantly in motion.

When the bath grows weak, and the green colour diminiſhes, a brevet is given it, into which are put a pound of *cendres gravelées*, an ounce of madder, and a handful of bran, well waſhed. When the indigo is exhauſted, more of that alſo muſt be put in, with the due proportions of *cendres gravelées*, madder, and bran.

Some dyers uſe vats that are grown weak to dye light ſhades: but the blue then obtained is leſs beautiful, and leſs permanent, than when freſh vats containing a ſmaller quantity of indigo are employed.

Indigo alone is incapable of giving ſilk a deep blue: hence, when this is required, it is neceſſary to prepare it, by giving it another colour, or ground. For the *Turkey* blue, which is the deepeſt, a very ſtrong archil bath is firſt given, and for the royal blue *(blue de roi)*, one

of

of the ſame kind, but weaker. Other blues are dyed without any ground.

There is a blue made, as deep as the royal blue, for the ground of which cochineal is uſed inſtead of archil, in order to render it more permanent, whence it is called *bleu fin*.

A blue of little durability is given to ſilk by means of verdegris and logwood: but it might be made more laſting, by firſt giving it a lighter ſhade than is intended, in a bath of this kind, afterwards dipping it in an archil bath, and laſtly in the vat.

To dye raw ſilk blue, that ſhould be choſen which is naturally white. It ſhould be thoroughly ſoaked in water, and afterwards put into the vat in ſeparate hanks, in the ſame manner as the ſcoured *(cuite)* ſilk. In general raw ſilk takes the dye more readily, and, if it be poſſible, the ſcoured ſilk is put into the vat before it. If raw ſilk require archil, or the other ingredients above-mentioned, it is to be treated in the manner above deſcribed.

According to Mr. Pileur d'Apligny, the vat for dyeing linen and cotton is a caſk of about a hundred and twenty gallons. The quantity of indigo uſed is generally from ſix to eight

pounds.

pounds. This indigo, after being pounded, is boiled in a ley drawn off clear from a quantity of lime equal to the indigo, and double its weight of pot-afh. The boiling is continued till the indigo is thoroughly penetrated by the ley, carefully ftirring it all the while, that the indigo may not ftick to the bottom of the veffel and burn.

Whilft the indigo is boiling, an equal weight of quick-lime is to be flacked. About twenty quarts of warm water are added, and in this is diffolved as much vitriol or fulphat of iron as amounts to twice the weight of the lime. When the folution is completed, the liquor is to be poured into the vat, which muft be previoufly half filled with water. To this the folution of the indigo muft be added, with the remainder of the ley which was not ufed in boiling it. When all thefe are put into the vat, it is to be filled up to within two or three fingers of the brim, and ftirred with the rake two or three times a day, till it is in a ftate fit for dyeing, which it will be in eight and forty hours, and frequently fooner, according to the temperature of the atmofphere, on which, the time required to make this vat depends.

Some add to a vat compoſed nearly in the ſame manner as the foregoing, a little bran, madder, and paſtel [d].

At Rouen a more ſimple proceſs is followed, which Mr. Quatremere thus deſcribes. '

' The vats are conſtructed of a kind of flint, covered within and without with a coating of fine cement. In every dye-houſe there is a certain number, arranged in one or more parallel lines. Each vat is capable of containing four hogſheads of water, and into it may be put eighteen or twenty pounds of indigo. The indigo having been macerated for a week in a cauſtic ley ſufficiently ſtrong to bear an egg, and then ground in a mill, in which not unfrequently the maceration is made, about three hogſheads and a half of water are put into the vat, and afterwards twenty pounds of lime. When the lime is thoroughly ſlacked, the vat is raked, and ſix and thirty pounds of ſulphat of iron or engliſh copperas are put in. When the ſolution is completed, the ground indigo is poured in through a ſieve. On that day it is raked ſeven or eight times: and, after hav-

[d] Procès-verbal des opérations de teint faites à Yvetot par François Gonin.

ing

ing ſtood at reſt ſix and thirty hours, it is fit for dyeing.

It is neceſſary to have vats ſet at different times. The cotton, or thread, is firſt dipped in that which is moſt exhauſted, going on from vat to vat, till it comes to the ſtrongeſt, unleſs it have before attained the proper ſhade. It ſhould be wetted before it is put into the firſt vat, and ſhould not be left in the bath more than five or ſix minutes, as in that time it will have acquired nearly all the blue it can take up.

As ſoon as the dyeing in one vat is over, it ſhould be raked, and not uſed again, till it has ſtood at leaſt four and twenty hours unleſs it be newly ſet, when it need not ſtand quite ſo long.

When a vat has been dyed in three or four times, it begins to change: no more veins are ſeen on its ſurface after raking it, or it grows black. It is then neceſſary to *repleniſh (renourrir)* it, and for that purpoſe four pounds of ſulphat of iron, with two of quick-lime, are added, and it is raked twice. A vat may be repleniſhed three or four times, diminiſhing the ingredients in proportion as it falls off in ſtrength and quality.

This

This vat may be rendered ftill more fimple. It may be compofed, as directed by Bergman, in the following proportions. Take three drams of indigo powdered, three drams of fulphat of iron, fix drams of lime, and two pints of water. Rake it well, and in a few hours the vat will be ready for dyeing.

Mr. Hauffman defcribes a vat differing from the foregoing, only in the proportions of the ingredients. In it the indigo is in much fmaller quantity. For three thoufand pounds of water he takes thirty-fix pounds of quick-lime, which he flacks in two hundred pounds of water: with this he mixes the indigo well ground: thirty pounds of fulphat of iron, perfectly free from copper, he diffolves in a hundred and twenty pounds of hot water: having left the whole at reft for a quarter of an hour, he finifhes the filling of the vat, gently ftirring it without intermiffion. He very juftly obferves, that the blue vat may be made with fine or common indigo at difcretion, nothing more being neceffary than to vary the quantity. From twelve to twenty pounds may be taken for the quantity of water above directed: nay fomewhat more, if a colour like that of indigo in fubftance be required, particularly when it is

for

for dyeing linen. The ſhade depends greatly too, on the time the goods are left in the vat, and the times it has been uſed. It is eaſy, however, to obtain always the ſame ſhade nearly: nothing more being neceſſary for that purpoſe, than to add, from time to time, a certain quantity of a ſolution of indigo, prepared with the leaſt water poſſible.

When this vat begins to grow turbid, dyeing in it muſt be diſcontinued. It muſt then be ſtirred, and left till the liquor above the ſediment becomes clear. When the operation of dyeing in it is interrupted, it muſt be ſtirred a few times a week.

If the lime fail, from being ſaturated with carbonic acid, more muſt be added, after being ſlacked in a proper quantity of water. If the iron be too much oxydated to act on the indigo, ſulphat of iron is to be added, always taking care, that there be more lime than is neceſſary to ſaturate the ſulphuric acid; for it muſt not be forgotten, that a certain portion is wanted to diſſolve the indigo.

When the indigo is exhauſted, it ſuffices to add a freſh portion ground in water, to ſtir the vat a few times, and to let it ſettle; after which it is fit for dyeing afreſh. With theſe precautions, Mr. Hauſſman preſerved the ſame vat

for

for two years: and it might have been ufed much longer, if the accumulation of fediment had not been fo great as to render it impracti-cable to dip any thing in it fufficiently deep.

Mr. Hauffman found, that a pattern of cot-ton cloth, dipped into water acidulated with fulphuric acid after it was taken out of this vat, acquired a blue more intenfe than a fimilar pattern left expofed to the air, or another put into river water.

Bergman mentions another vat, very con-venient and expeditious for dyeing thread or cotton, which is thus defcribed by Scheffer [*]. To very ftrong foap-boiler's ley indigo well powdered is added; in the proportion of three drams to a quart. After a few minutes, when the colouring feculæ are well penetrated by the ley, fix drams of powdered orpiment are added. The bath is to be well raked, and in a few minutes it becomes green, and ex-hibits the blue flower with a pellicle at top, when the fire is to be put out, and the dyeing to commence.

This vat does not differ from the prepa-ration employed for printing cottons, which is called *bleu d'application*, except in the propor-

[*] Effai fur l'art de la teinture.

tions of orpiment and indigo, which are much greater in the latter, particularly the indigo. For this preparation, according to Mr. Hauſſman, thirty pounds of pot-aſh, twelve of quick-lime, twelve of orpiment, and ſixteen of indigo, to a hundred quarts of water, are taken; and it is thickened with gum, that it may be applied with a pencil, or a ſtamp. Mr. Oberkampf, all whoſe proceſſes have been improved with great care, uſes a ſtill greater proportion of indigo. In Bergman's proceſs, the indigo is ſcarcely an eightieth part of the water: in that of Scheffer ſtill leſs: a twelfth in that of Mr. Hauſſman: and an eighth in Mr. Oberkampf's. The proportions of the other ingredients in theſe proceſſes alſo vary. Apparently theſe preparations would ſucceed on a ſcale in which the proportions ſhould be greatly augmented, and there would be no difficulty in determining which would beſt attain the object propoſed.

CHAP. IV.

Of Saxon Blue.

THE colour dyed by means of a ſolution of indigo in ſulphuric or vitriolic acid has received the appellation of *ſaxon blue*, from having been diſcovered at Groſſenhayn in Saxony, by counſellor Barth, about the year 1740. This diſcovery was kept ſecret for a time, but by degrees it got abroad. At firſt the ſolution was not made with indigo alone; but alumine, antimony, and other mineral ſubſtances were previouſly digeſted in the ſulphuric acid, the indigo was added afterwards, and when the ſolution was finiſhed, it was employed for dyeing.

Bergman made many experiments on this proceſs, and he thinks, that if it has hitherto afforded only a fading colour, it has been becauſe the acid uſed was too weak.

He puts, as has been already ſaid, one part of indigo finely powdered into eight parts of ſulphuric or vitriolic acid, ſo concentrated, that its ſpecific gravity is to that of diſtilled water as 1900 to 1000. The mixture being made in

in a glaſs veſſel ſlightly ſtopped, a great heat is excited. After a digeſtion of twenty-four hours, in a heat of 30 degrees or 40 degrees (100 or 122 Farh.) the indigo is diſſolved, but the mixture is quite opake and black: by the addition of water it is rendered clear, and affords ſucceſſively the various ſhades of blue, according to the quantity of water added. In a great number of experiments deſcribed by that illuſtrious chemiſt, he kept the ſtuff to be dyed twenty-four hours in boiling water, and then put a given weight into the bath more or leſs ſtrong, till the colour of the bath was exhauſted. From theſe experiments it appeared, that one part of indigo would in this way produce a deep blue on two hundred and ſixty parts of ſtuff, which appeared to be then ſaturated, and incapable of taking up more indigo, at leaſt ſo as to be fixed in it: that the cold bath acts equally with the hot: that the operation may be performed without waſte of indigo; for the bath may be totally exhauſted of its colour; and if it had too much, ſtuff not ſaturated may be added, by which all that remains will be abſorbed: and that the bath, if ſaturated with ſalt of ſoda, gives only a very pale colour, if with ſulphat of ſoda, a light

blue, though much leſs weak; ſo that theſe ſalts are more or leſs injurious to the dye.

Similar experiments w re made on ſilk, ſoaked in like manner in boiling water, and taken out of the bath after the ſpace of a hundred and forty-four hours. The indigo ſolution gave a blue to the ſilk, as well as to the ſtuff, but the attraction by which the former precipitates the blue particles is more weak. The patterns of ſilk reſiſted the action of water alone very well, but they could not bear that of ſoap.

Thread and cotton took only very pale ſhades from this dye.

The deepeſt ſhades obtained by this proceſs, when concentrated ſulphuric acid is employed, ſuffer no change, as Bergman aſſures us. He ſays, that having expoſed all the patterns to the ſun for two months, the deep blues (ſuch as are known with us by the name of Coventry blues) *bleus pers & turquins*, were ſcarcely weakened; but that the light ſhades ſuffered much more, becoming dull and greeniſh.

Mr. Quatremere ſays, that, among ſeveral dye-houſes, he found only two, in which it was known how to make the dye of indigo with ſulphuric acid penetrate into the internal part of

of the ſtuff, when the colour is ſaid to pierce or *cut (percer on trancher)*: and that he gave it this property, by introducing fixed alkali, one ounce to an ounce of indigo and ſix ounces of ſulphuric acid. With this preparation he dyed a pattern of a moſt deep and vivid blue, and the cut was as deeply tinged as the ſurface.

Mr. Poerner, who has paid great attention to this preparation, adopts the addition of alkali [a]. He ſays, that by means of it, the colour is rendered more pleaſing, and penetrates deeper. He directs only four parts of ſulphuric acid to one of indigo. In the proceſs deſcribed by him, four parts of concentrated ſulphuric acid are poured on one of indigo reduced to a fine powder: the mixture is ſtirred for ſome time: after having ſtood twenty-four hours, one part of good dry pot-aſh in fine powder is added: the whole is again well ſtirred, and, having ſtood twenty-four hours longer, more or leſs water is added gradually.

The ſame author ſays, that he has diſcovered a preparation of indigo in a dry form, which is more advantageous, more eaſy to be uſed, and more convenient than the preceding, but that he cannot yet communicate it to the public.

[a] Inſtruction ſur l'art de la teinture, &c.

To dye ſaxon blue, the cloth is prepared with alum and tartar. A greater or leſs proportion of the ſolution of indigo is to be put into the bath, according as the ſhade required is deep or light. In the dye-houſe this ſolution is called *compoſition*, and the colour obtained by it frequently *pruſſian blue*. The light ſhades may be dyed after the deep ones: but they have more luſtre when dyed in a freſh bath. For deep ſhades it is beſt to put in the ſolution of indigo in different portions, raiſing the cloth on the winch.

When I come to treat of green in the ſixth ſection, I ſhall give a further account of this dye, and of the *engliſh blue*, which is a variation of it.

CHAP. V.

Of Dyeing Blue by Means of Pruſſian Blue.

AS pruſſian blue furniſhes the painter with a beautiful and permanent colour, attempts have been made to employ it in dyeing. Macquer, after having made many important

obſervations on that ſubſtance, has endeavoured to render it uſeful in this art [a].

I ſhall not ſtop to deſcribe the properties of pruſſian blue, which have exercifed the ſagacity of many chemiſts, particularly of Macquer and Scheele: I ſhall only endeavour to give a ſufficient idea of it. It is then, a combination of iron with a peculiar acid, which acid is formed by calcining animal ſubſtances with alkali, and which is diſtinguiſhed by the name of pruſſic, whence its compounds are called pruſſiats. The pruſſiat of iron retains a little alkali, and from the nature of the compound, the iron in it is but little oxydated, ſo that it retains the black colour proper to it in that ſtate. This colour a little modified is probably the principle of the colour of pruſſian blue, conformably to the principles eſtabliſhed in the former part of this work.

Alkali, when digeſted on pruſſian blue, or pruſſiat of iron, takes from the iron the pruſſic acid; and if in this ſtate of combination, it be mixed with a ſolution of iron, an exchange takes place, the alkali uniting with the acid which held the iron in ſolution, and the iron combining with the pruſſic acid. But when

[a] Mém. de l'acad. 1749.

the alkali takes the pruſſic acid from the iron, it at the ſame time diſſolves a portion of the metal; and when the iron reſumes the pruſſic acid, it retains a portion of the alkali: ſo that both the pruſſiat of alkali, and the pruſſiat of iron, ought to be conſidered as triple compounds [b].

Macquer's firſt attempt was to ſoak thread, cotton, wool, and ſilk, in a ſolution of alum and ſulphat of iron; then in an alkaline ſolution partly ſaturated with pruſſic acid; and next in water acidulated with ſulphuric acid, which was to diſſolve that part of the oxyd of iron not combined with the pruſſic acid, which the alkali not combined with that acid had precipitated. Repeating ſucceſſively theſe immerſions, he obtained a fine blue, but very unequal: and the wool and ſilk were become harſh to the touch, from the action of the alkali, and of the ſulphuric acid.

It is eaſy to perceive, that this proceſs could not ſucceed. For as an alkali not ſaturated with pruſſic acid was uſed in the ſecond immerſion, that part of the alkali which was not ſaturated muſt diſſolve more or leſs of the blue taken up in the firſt. If any one, therefore,

[b] Mém. de l'acad. 1786.

would

would repeat thefe experiments, he fhould employ an alkali faturated with pruffic acid; or perhaps lime-water, or rather magnefia, both of which have the property of combining with that acid.

In a fecond procefs, that learned chemift boiled his patterns in a folution of alum and tartar, and afterwards paffed them through a bath in which pruffian blue was mechanically diffufed. They were now dyed evenly and foft to the touch; but the colour was faint, and it was impoffible to render it deeper.

Abbé Menon propofes another procefs for thread and cotton. It confifts in firft dyeing them black: then foaking them a few minutes in a folution of pruffiat of alkali: and afterwards boiling them in a folution of alum, in which they acquire a very deep blue. If a lighter blue be required, they muft be paffed through a weak acid. This procefs is curious: in it the pruffic acid appears to take the place of the aftringent principle.

Many trials have been made to turn thefe experiments to advantage, particularly the firft: but whatever care has been taken, the colour was frequently weak, dull, and uneven. They feem therefore, to have been renounced, and the only one now ufed has confiderable analogy

to

to the ſecond of Macquer. In this the pruſſian blue is merely diluted by means of muriatic acid, which does not form with it a true ſolution, but attenuates it ſufficiently to make it penetrate more copiouſly into cotton ſtuffs [c]. I ſhall quote literally the deſcription given of it by Mr. Roland de la Platiere, which agrees with the practice of certain dyers.

On fine pruſſian blue, in the proportion of a pound to a piece of ſtuff, powdered and paſſed through a very fine ſieve, pour, in a veſſel of delft ware, as much marine acid as will reduce it to the conſiſtence of a ſyrup. Stir it continually whilſt it ferments for about half an hour. Dilute it well, and ſtir it every hour for a day, till no more fermentation is perceptible, the particles are extremely divided, and intimately united with the acid.

In a trough narrower than the common ones, but widening more toward the top, being two feet and a half high, two feet and a half diameter at top, and two feet at bottom, put ſeven or eight buckets of water for one piece of velvet. To theſe add the compoſition, well diluted with water in a ſeparate veſſel, and poured into the bath through a very fine ſieve. As

[c] L'Art du fabricant de velours de coton.

ſoon as the piece is placed on the winch over the trough, ſtir the bath very briſkly, and let down the piece ſpeedily, working as faſt as poſſible for one, two, or three hours; paſſing the piece ſucceſſively from the winch to the horſe or board (planche) and from the board to the winch.

As the pruſſian blue is not really diſſolved, but only very minutely divided, and is weighty, it is quickly depoſited on the ſtuff, and always in greateſt quantity on the firſt that preſents itſelf. Hence it follows, that the colour is at firſt wavy and frequently in patches, whatever care be taken. At this we ſhould not be ſurpriſed, though we ought to avoid it as much as poſſible; work and rework the ſtuff; waſh the parts that have taken too much colour with the bath itſelf; work it over again, now one end firſt, then the other; dry it; work it again, always as evenly and ſpeedily as poſſible; dry it once more, if neceſſary, and work it again, till we attain the proper ſhade, and the colour be perfectly even. There is no colour that requires a more experienced workman than this. The ſtuff is always to be waſhed and beetled between the dryings. In all kinds of baths it is neceſſary, that the ſtuff be put in thoroughly wet: if dry, the colour will not

penetrate

penetrate it without great difficulty, and always very unequally. The laſt time it is not waſhed, and is dried on the tenters (rame) in the open air, either in the ſun or in the ſhade, provided the piece be well ſtretched.

This colour, one of the moſt beautiful produced by art, is not changed by the air, though expoſed to all its viciſſitudes. Mr. Roland de la Patiere left patterns of it in the open air for ſix months together: for a long time the colour heightened *(a remonté)* and at laſt had loſt but little. Acids are not injurious to it: boiling with alum even produces in it but little alteration. Duſt, however, and rubbing on the creaſes of it, ſoon tarniſh it; and the leaſt touch of an alkaline liquor decompoſes it inſtantly.

Inſtead of the muriatic acid, Mr. Guliche uſes a ſolution of tin in nitro-muriatic acid for this operation.

Formerly a kind of ſea green (celadon) was made with ſulphat of copper; but this colour, which approaches very near to blue, poſſeſſes no durability, and is no longer in uſe; I ſhall however, mention the proceſſes for it. The cloth after having been fulled and moiſtened with warm water, was left for an hour in ſtrong ſoap-ſuds, after which it was kept half an hour

or

or three quarters of an hour, in a ſolution of ſulphat of copper or blue vitriol; a net was employed to prevent the cloth from being rendered dull by the ſediment from the ſoap and ſulphat of copper; ſometimes in order to produce a more diſtinct green, a ſolution of copper was mixed with a bath of weld; ſometimes verdegris was ſubſtituted for ſulphat of copper. Hellot deſcribes a ſomewhat different proceſs, by which the Dutch produced this colour in perfection. He ſays, that they mixed together equal parts of lime and ſulphat of copper in a bag, and turned the cloth out of the copper with the ſoap-ſuds, into another that was contiguous, in which the particles of the copper that paſſed through the bag, gave it the green colour.

SECTION

SECTION III.

Of Red.

CHAP. I.

Of Madder.

MADDER, a ſubſtance very extenſively employed in dyeing, is the root of a plant which Linnæus divides into two ſpecies, the firſt, *rubia tinctorum foliis ſenis*, the ſecond, *rubia peregrina foliis quaternis*. Of the firſt there are two varieties, the cultivated madder and the wild madder, called alſo *rubia ſylveſtris monſpeſſulana major*.

Although madder will grow both in a ſtiff clayey ſoil and in ſand, it ſucceeds better in a moderately rich, ſoft, and ſomewhat ſandy ſoil, it is cultivated in many of our provinces, in Alſace, Normandy, and Provence, the beſt of European growth, is that which comes from Zealand.

There

There are various methods of cultivating and preparing madder, and many treatiſes have been written on the ſubject, that of Mr. Duhamel may be conſulted, but more particularly that of Mr. le Pileur d'Apligny, publiſhed at the end of his art of dyeing threads and cotton ſtuffs.

The madder prepared for dyeing is diſtinguiſhed into different ſorts, that obtained from the principal roots is called *grape madder* (garance grape) the *non grape* is that which is produced from the ſtalks, which by being buried in the earth, are transformed into roots, and are called layers, *couchis*, each of theſe kinds is ſubdivided into robée, mi-robée, non robée, ſhort or muil (mûle) [a].

When the madder roots are gathered, the layers are ſeparated from them, to form the non grape, and ſuch of the ſibres of the roots as do not exceed a certain degree of thickneſs are added, as are alſo thoſe roots which are too thick, and which contain a great deal of heart or ligneous part : the beſt roots are about the thickneſs of a gooſe quill, or at moſt of one's little finger ; they are ſemi-tranſparent

[a] For an explanation of theſe terms, vide page 113.

and

and of a reddiſh colour, they have a ſtrong ſmell, and the bark is ſmooth.

When the madder is gathered and picked, it muſt be dried, in order to render it fit for grinding and being preſerved: in warm climates it is dried in the open air; in Holland, by means of ſtoves, which ſometimes communicate too great a degree of heat, and change its colour by an admixture of fuliginous particles. Heliot aſcribes the ſuperiority of the madder which comes from the Levant, to the circumſtance of its having been dried in the open air.

After the root has been dried, it muſt be ſhaken in a ſack, or lightly beaten on a wooden hurdle, after which it muſt be ſifted or winnowed. In this way the earth is ſeparated from it, and the *billon* is removed, a name by which the ſmall roots and their bark are diſtinguiſhed. After this, nothing remains but to reduce it to powder, which may be done by a vertical millſtone, or by peſtles, or even by a common ſnuff mill.

All the parts of the madder cannot be powdered with equal facility; the outer bark and ligenous parts are more eaſily pounded than the parenchymatous parts. Advantage is taken of this circumſtance in order to ſeparate thoſe parts,

parts, as they do not all give the ſame colour; the outer bark as well as the wood within, afford a yellowiſh colour, which ſpoils the red we wiſh to obtain. This ſeparation eſtabliſhed the diſtinction of madder into robée, mi-robée, and courte. After the firſt operation of the mill, the madder is paſſed through a ſieve with a cover fitted to it, by which means, what is called the ſhort madder, which is intended for tan and mordoré colours is obtained; the remainder is again ground and ſifted, and thus the mi-robée is obtained; and a third operation affords the robée. The madder thus powdered is to be preſerved in a dry place, well packed in caſks, where from its natural unctuoſity it concretes into lumps.

Mr. Beckmann [b] agrees with Mr. Hellot in opinion, that the heat of ſtoves injures the colour of madder, and that it would be better to dry it in the air only, the effect of which might be promoted by various means. He finds that common ovens, immediately after the bread is taken out, may be uſed inſtead of the dutch ſtoves, when artificial heat is to be employed. Mr. d'Ambourney [c] has made

[b] Nov. comment. ſociet. reg. Gotting. tom. viii.

[c] Délibér. & mem. de la ſociété d'agriculture de la generalité de Rouen.

fome interefting experiments on madder; he thinks that the frefh root may be ufed in dyeing, with as much advantage as the powdered. He obferved, that four pounds of the frefh are equal to one of the dried, although in the drying feven eighths of its weight are loft; the expence of ftoving, packing, and fifting are faved, and it is only neceffary to take care that the roots be thoroughly wafhed in a current of water, as foon as they are taken out of the ground; they are afterwards cut into pieces and bruifed by the vertical mill. In dyeing with the frefh roots, on account of the quantity of water they contain, we muft take care not to put too much water into the bath. Mr. Beckmann fubfcribes to Mr. d'Ambourney's opinion, though he has conftantly made one obfervation which feems to contradict it; that madder is more fit for dyeing, after having been preferved for two or three years, than when frefh.

In the neighbourhood of Smyrna, and in the ifland of Cyprus, a kind of madder is cultivated, which affords a more lively red than that raifed in Europe; on which account, it is employed in the preparation of the Adrianople red. In the countries where it grows it is called *chioeborza*, and *hazala*, but it is

commonly

commonly known by the name *lizari*. It is now cultivated in Provence, and Mr. Beckmann has raiſed it with great ſucceſs at Gottingen.

The red colouring matter of madder may be diſſolved in alcohol, and on evaporation, a reſiduum of a deep red is left. Fixed alkali forms in this ſolution a violet, the ſulphuric acid a fawn coloured, and the ſulphat of potaſh a fine red precipitate. Precipitates of various ſhades may be obtained by alum, nitre, chalk, acetite of lead, and muriat of tin.

In macerating madder in ſeveral portions of cold water ſucceſſively, the laſt receives only a fawn colour, which appears entirely different from the peculiar colouring particles of this ſubſtance, and reſembles that which is extracted from woods and other roots; this fawn coloured ſubſtance perhaps, does not belong to the pulp, and is only found in the ligneous and cortical parts.

After having by repeated boiling exhauſted the madder of the colouring parts that are ſoluble in water, it ſtill retained a deep colour, and alkali extracted from it much colouring ſubſtance; the reſiduum which ſtill remained coloured, was very inconſiderable, ſo that the pulp appears wholely compoſed of colouring

 matter,

matter, a good part of which is not ſoluble in ſimple water.

Oxygenated muriatic acid employed in ſufficient quantity to change an infuſion of madder from a red to a yellow colour, produces a ſmall quantity of a very pale yellow precipitate, and the ſupernatant liquor is tranſparent, retaining a greeniſh yellow colour more or leſs deep, according to the quantity and ſtrength of the oxygenated muriatic acid.

The quantity of this liquor required to deſtroy the colour of a decoction of madder, is double what is neceſſary to deſtroy that of a decoction of an equal weight of braſil wood, which proves, that the colouring particles of madder are much better calculated to reſiſt the influence of the air, than thoſe of braſil wood, they would be eaſily changed however, if not rendered fixed by mordants. To this, I ſhall add ſome of the celebrated Mr. Watt's experiments, which he has been ſo kind as to communicate to me, and which he made with the beſt Zealand madder.

A. This madder is of a browniſh orange colour, and of the conſiſtence of a coarſe powder poſſeſſing a ſlight degree of coheſion: it attracts moiſture, in which caſe it loſes its properties,

properties, ſo as to become unfit for the purpoſes of dyeing.

B. With water it affords an infuſion of a browniſh orange colour; its colour cannot be extracted without a great deal of water, Margraff directs three quarts of water for two ounces of madder. Its colouring particles may be extracted either by hot or cold water; to the latter it appears to give a more beautiful colour; its decoction is browniſh.

C. When an infuſion or decoction of it is ſlowly evaporated in an open veſſel, a pellicle is formed on the ſurface, which gradually falls to the bottom, after which freſh pellicles are ſucceſſively formed until the evaporation is finiſhed.

D. The extract thus prepared is of a dark brown, it partly diſſolves in water, to which it communicates a lightiſh brown colour.

E. The infuſion ſet to digeſt for ſome days in an open veſſel, which ſhould be of ſuch a height, that the liquor reduced to the form of vapour, may fall back again, depoſits dark brown pellicles, the liquor remains of a browniſh colour, and the pellicles are ſoluble in water, but with difficulty.

F. Alum forms in the infuſion B a deep browniſh red precipitate compoſed of pellicles,

and the ſupernatant liquor is of a yellow colour inclining to brown.

G. Alkaline carbonats precipitate from this laſt liquor a lake of a blood red colour, which has greater or leſs intenſity according to the quantity of alum that has been diſſolved in it. In this way a blood red lake may be obtained; but we cannot by any means hitherto known, give it the brightneſs of cochineal lake; in oil it is tranſparent, but in water it is opake and without beauty.

H. If a ſuperabundant quantity of alkali be employed, the precipitate is rediſſolved, and the liquor becomes red.

I. The lake precipitated by pot-aſh, is of a more beautiful colour than that by the mineral alkali.

K. Calcareous earth precipitates a more dark and brown coloured lake than alkalis, particul. rly if it forms lime water.

L. If a few drops of alkali are added to the water employed in making the infuſion B, the infuſion extracts many colouring particles of a deep red bordering on brown. 1ſt. Alum precipitates a deep brown lake from this infuſion. 2dly. Acids added in ſmall quantity change it to a yellowiſh colour, and in greater quantity render it a brown yellow, but they

precipitate

precipitate nothing from it. 3dly. This infusion evaporated to dryneſs, forms a gummy extract; which eaſily diſſolves in water.

M. If the infuſion B is made with water very ſlightly acidulated with a mineral acid, it is yellowiſh. 1ſt. This liquor long digeſted becomes of a greeniſh brown, and the yellow appears to be deſtroyed. 2dly. The addition of an alkali reſtores the red colour, and the infuſion then gives on evaporation an extract which readily diſſolves in water.

N. If carbonat of magneſia be added to the water uſed for the infuſion B, the infuſion is of a clear blood red, and on evaporation forms a blood red extract, which readily diſſolves in water. 1ſt. A ſolution of this extract which is employed as a red ink, when expoſed to the light of the ſun becomes yellow. 2dly. Alum precipitates from this infuſion a ſmall quantity of an ill-coloured lake. 3dly. Alkalis give it a redder and more fixed colour.

O. If the infuſion be made with a ſolution of alum, it is of an orange yellow. 1ſt. This infuſion precipitated by an alkali, gives a lake reſembling that of F, but its colour is not ſo good.

P. A ſolution of acetite of lead added to the infuſion B, forms a browniſh red precipitate. 1ſt. A ſolution of mercury in the nitric acid gives a purple brown precipitate. 2dly. A ſolution of ſulphat of iron, a fine bright brown precipitate. 3dly. A ſolution of ſulphat of zinc has not been tried. 4thly. A ſolution of ſulphat of manganeſe, a purple brown precipitate. 5thly. A ſolution of iron in the nitro muriatic acid has not been tried.

Q. The infuſion B being mixed while hot with the infuſion of cochineal, a browniſh red precipitate bordering on a deep purple was formed, of difficult ſolubility in water; by continuing the digeſtion, a greater quantity of this precipitate appeared. 1ſt. A pattern ſoaked in a preparation which the linen printers uſe, having been dyed in this mixture, took a browniſh red colour, and after having been boiled in a ſolution of ſoap, the colour appeared pretty good. 2dly. The ſolution of ſoap became very red, it communicated however a very indifferent colour to paper.

CHAP. II.

Of the Processes employed in Dyeing with Madder.

WOOL would receive from madder, as has been already stated, only a perishable colour, if its colouring particles were not fixed by a base which occasions them to combine with the stuff more intimately, and which in some measure, defends them from the destructive influence of the air. For this purpose, the woollen stuffs are first boiled for two or three hours with alum and tartar, after which they are left to drain, they are then slightly wrung and put into a linen bag, and carried into a cool place, where they are suffered to remain for some days.

The quantities of alum and tartar as well as their proportions, vary much in different manufactories: Hellot recommends five ounces of alum and one ounce of tartar to each pound of wool; if the proportion of tartar be increased to a certain degree, instead of a red, a deep and durable cinnamon colour is produced, because as we have seen, acids have a tendency

to

to give a yellow tinge to the colouring particles of madder. Mr. Poener somewhat diminishes the proportion of tartar, he directs that it should be only one seventh of the alum; Scheffer, on the contrary, directs that the quantity of tartar should be double that of the alum, but I have found that by employing one half tartar, the colour sensibly bordered more on the cinnamon, than when the proportion was only one fourth of the alum.

In dyeing with madder, the bath must not be permitted to boil, because that degree of heat would dissove the fawn coloured particles which are less soluble than the red, and the colour would be different from that which we wish to obtain.

When the water is at a degree of heat which the hand can bear, Hellot directs us to throw in half a pound of the best grape madder for each pound of wool to be dyed, and to stir it well before the wool is put in, which must remain for an hour without boiling, but in order to be more certain of the dye, it may be boiled for four or five minutes towards the end of the operation. Mr. Beckmann advises the addition of a little alkali to the madder bath; I approve the plan in the dyeing of thread and cottons.

By

By this proceſs reds are obtained which are never ſo beautiful as thoſe produced even by kermes, much leſs, thoſe from lake and cochineal; but as they coſt but little, they are uſed for common low priced ſtuffs. The madder reds are ſometimes roſed with archil and braſil-wood, in order to render them more beautiful and more velvety, but the brightneſs given them in this way is not laſting.

The quantity of madder which Mr. Poerner employs is only one third of the weight of the wool, and Scheffer adviſes only one fourth. Mr. Poerner ſays, that having added to the alum and tartar, a quantity of ſolution of tin of equal weight with the tartar, and after two hours boiling, having let the cloth remain in the bath that had been left to cool for three or four days, he dyed it in the uſual way, and obtained a pleaſing red. He deſcribes another proceſs, in which, after having prepared the cloth by the common boiling, he dyed it in a bath but ſlightly heated with a larger quantity of madder, tartar, and ſolution of tin; he let the cloth remain twenty-four hours in the bath, and after it had become cold, he put it into another bath made with madder only, and there left it for twenty-four hours; in this way he obtained a pleaſing red, ſomewhat clearer than the

the common red, and bordering a little on a yellow. According to Scheffer, by boiling wool with a ſolution of tin, the quantity of which he does not mention, with one fourth of alum, and by dyeing with one fourth of madder, an orange red is obtained.

Bergman ſays, that if without boiling the wool, it be dyed with one part of a ſolution of tin, and two parts of madder, it acquires a cherry colour, which when expoſed to the air acquires a deeper tinge.

If wool be boiled for two hours with one fourth of ſulphat of iron, then waſhed, and afterwards put into cold water with one fourth of madder and then boiled for an hour, a coffee colour is produced; Bergman adds, that if the wool has not been ſoaked, and if it be dyed with one part of ſulphat of iron and two of madder, the brown obtained, borders upon a red.

According to theſe chemiſts, by employing ſulphat of copper as a mordant, we obtain from madder a clear brown bordering on yellow. A colour of the ſame kind will be produced, by dyeing the wool ſimply ſoaked in hot water, with one part of ſulphat of copper and two of madder; if equal parts of theſe two ſubſtances be uſed, the yellow will be ſomewhat more ob-

ſcure, bordering on a green; in both theſe caſes, the colour does not become darker by expoſure to the air.

I have employed a ſolution of tin in various ways, both in the preparation and in the maddering of cloth. I have uſed different ſolutions of tin, and I have found, that the tint was always more yellow or fawn coloured, although ſometimes brighter than that obtained by the common proceſs.

Madder does not afford a colour ſufficiently bright for dyeing ſilk; de la Folie, however, has given us a proceſs for employing it for this purpoſe.

Half a pound of alum is to be diſſolved in each quart of hot water, to which two ounces of pot-aſh are to be added; after the efferveſcence has ceaſed, and the liquor has begun to grow clear, the ſilk muſt be ſoaked in it for two hours, it is then to be waſhed and put into a madder bath; ſilk dyed in this way becomes more beautiful by the ſoap proof[a]. Scheffer gives us a ſomewhat different proceſs; the ſilk is to be alumed in a ſolution of four ounces of alum with ſix drams of chalk for each pound of ſcoured ſilk; when a ſediment

[a] Journal de Phyſique, t. xiii. p. 66.

is formed, the solution is to be decanted, and after having become quite cold, the silk is to be put into it, and to be left eighteen hours; it is then to be taken out and dried, after which it is to be dyed with an equal weight of madder, when it takes a pretty good, but rather dark red. Mr. Guliche also describes a process for dyeing silk with madder [b]; for one pound of silk he orders a bath of four ounces of alum and one ounce of a solution of tin; the liquor is to be left to settle, when it is to be decanted, and the silk carefully soaked in it, and left for twelve hours, and after this preparation, it is to be immersed in a bath containing half a pound of madder softened by boiling with an infusion of galls in white wine; this bath is to be kept moderately hot for an hour, after which it is to be made to boil for two minutes. When taken from the bath, the silk is to be washed in a stream of water and dried in the sun. Mr. Guliche compares the colour thus obtained, which is very permanent, to the turkey red. If the galls are left out, the colour is clearer. A great degree of brightness may be communicated to the first of these, by afterwards passing it through a bath of brasil wood

[b] Volstandiges farbe, &c. iv band.

to

to which one ounce of ſolution of tin has been added, the colour thus obtained, he ſays, is very beautiful and durable.

Madder is uſed for dyeing linen and cotton red, and even for giving them many other colours by means of different admixtures; it is the moſt uſeful of all the colouring ſubſtances employed in this kind of dyeing. It is proper to enter into a ſomewhat minute detail of the different means by which this kind of dye may be rendered more certain, more beautiful and varied. Thread does not ſo eaſily take a colour from madder as cotton, but the proceſſes which ſucceed beſt for the one are alſo to be preferred for the other.

The madder red of cotton is diſtinguiſhed into two kinds, the one is called ſimple madder red, the other, which is much brighter, is called Turkey or Adrianople red, becauſe it comes from the Levant, and has ſeldom been equalled in brightneſs or durability by our artiſts.

Madder reds likewiſe differ very much in brightneſs and permanency according to the proceſſes employed. We are indebted to Mr. Vogler for ſome very intereſting experiments on this ſubject, of which I ſhall now give a ſummary account. Mr. Vogler firſt conſiders the

the mordants, and afterwards the preparation of the madder bath[e].

The firſt mordant he tried, conſiſted of a ſolution of three drams of roman alum in fourteen ounces of water. Thread and cottons boiled for ſome minutes in this ſolution, and afterwards paſſed through the different madder baths, which will be hereafter deſcribed, took a ſlight poppy-coloured red. Our author obſerved in this, and many other experiments, that roman alum was much better than common alum, and gave greater brightneſs to the colours. He always uſed yellowiſh thread and cotton, which he firſt leyed, then waſhed and dried.

The above proportion of alum appeared to him the beſt, yet though he repeated the aluming three times, he was not able to give the thread and cotton a good colour. The addition of the ſmalleſt quantity of any kind of acid rendered it paler; the addition of arſenic produced no effect; ſheep and cow dung, and album grecum, added to the mordant, as alſo urine employed inſtead of water to diſſolve the alum, contributed ſomewhat, but not much,

[e] Crell neueſte entdeckungen, vol. xiii. An. de Chym. t. iv.

to

to ſtrengthen the colour. Muriat of ſoda and ammoniacal muriat had more effect, but theſe ſalts rendered the colour more dull; lime-water acted very much in the ſame way. The ſubſtances which had the beſt effect were gum arabic, ſtarch, fenugreek-ſeed, and above all, glue. The author ſays he has attempted to impregnate thread and cotton with fiſh oil, hogs-lard, and olive oil, but without ſucceſs. The gaſtric juice and the ſerous part of the blood of animals act like the glue.

The thread and cotton may be ſoaked alternately in a ſolution of glue and a ſolution of alum, or the glue may be diſſolved with the alum, in the proportion of from one dram and a half to four drams, with the quantity of alum directed. It is neceſſary to chooſe fine glue. This ſubſtance uſed with alum produces a more ſaturated colour, but without alum the red is duſky.

Muriat and nitrat of alumine not only produce a more intenſe and durable red than alum, but the tint is pleaſanter, more eſpecially when the nitrat is employed. In general, muriats render the colour darker, more ſaturated, and more durable. Corroſive mercurial muriat produces the ſame effect.

Having diſſolved in a ſtrong ley of pot-aſh, as much powdered white arſenic as it would take up with the aſſiſtance of heat, and having mixed this ſolution, which had been diluted with two parts of water, with a ſaturated ſolution of alum, the mixture became turbid and of the conſiſtence of jelly; it recovered its tranſparency on adding gradually a ſolution of alum.

Thread and cotton ſoaked for twelve hours in this mordant, when waſhed and dried received from madder a beautiful well ſaturated colour. Thread and cotton which had been for ſix hours in nitro-muriatic acid, and afterwards waſhed and dried, took from madder a more beautiful and durable colour, than that which dyers obtain from annotta; ſome bad madder by means of this mordant afforded a yellowiſh brown of an agreeable ſhade.

This colour may be changed into a poppy-coloured red, which may vie with the moſt beautiful colours of this hue obtained from braſil wood and cochineal, by firſt ſoaking the ſtuff in a ſolution of alum and common ſalt, and boiling it a ſecond time with madder.

Mr. Vogler macerated for a night three drams of pot-aſh with an equal quantity of com-

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mon madder in a pound of water, he then applied a boiling heat, and put into it ſome thread and ſome cotton, and after half a quarter of an hour's boiling, he took it out, rinſed and dried it, then ſoaked it in a ſolution of alum and common ſalt, after which he paſſed it through a ſolution of glue, and at laſt dipped it in a madder bath; it took a fine full red.

If to the preparation of madder and pot-aſh annotta be added, the thread and cotton take in this bath a beautiful orange colour; it is thus that the dyers in many places prepare that colour, but it is not ſo durable as that above deſcribed.

If inſtead of pot-aſh roman alum be employed, a colour is obtained which is at firſt weak though more lively than with the pot-aſh, and on going on with the proceſs a fine full red is obtained.

By giving a weak madder colour to thread and cotton that have been alumed, by afterwards ſoaking them in a ſolution of alum and ſalt, impregnating them with glue, and dyeing them a ſecond time in a madder bath, they take a beautiful very lively red.

The red of thread and cotton coloured by two madderings was very much weakened by the nitric, ſulphuric, and muriatic acids, dilu-

ted with two parts of water, and became more or leſs pale and yellow. The action of the nitric acid was the moſt powerful, and that of the muriatic the weakeſt; this laſt turned the colour brown. The vegetable acids have a much weaker action; a ſolution of alum powerfully diſſolved the colour, rendered it clearer, and at the ſame time brighter; potaſh and lime water have the property of extracting much of its colour, and changing it to a deep red.

Galls diſpoſe thread and cotton to receive the madder colour. Mr. Vogler's preparation for galling conſiſted of five drams of black galls, kept for twenty-four hours in a pound of water, which was then boiled for ten minutes, and ſometimes he added ſix drams of common ſalt. The galled thread and cotton after having received the mordants of alum and ſalt, took with the madder, a perfectly ſaturated colour but which was of a dark red. Thread and cotton ſucceſſively impregnated with a ſolution of tin and glue, ſteeped in an infuſion of cochineal and galls, waſhed and dried, and afterwards impregnated with the alum and ſalt mordant, and laſt of all dyed in a madder bath, received an uncommonly beautiful colour which was very bright and conſiderably durable.

durable. The mordant of alum and corrofive muriat of mercury and that of alum and falt gave a fomewhat deeper colour.

Mr. Vogler was equally fuccefsful, when inftead of galls he ufed feveral other vegetable aftringents, fuch as the ground bark of the alder and oak, the powdered bark of walnut-tree root, flowers and bark of pomegranate, the leaves, bark, and tops of the fumach. He made many experiments with metallic and earthy falts, all of which except the aluminous and the folution of tin, appeared to him to be but little adapted or entirely hurtful in the dyeing of red: we fhall communicate the principal refults.

The folution of nitrat of lead employed as a mordant, produced a very loaded dirty red inclining to brown. In general, folutions of lead ufed as mordants for thread and cotton difpofe them abundantly to receive colours from all vegetable colouring fubftances, but they have always a dark and dirty appearance. Thefe mordants may be employed for brown or black colours; the bad brown juft mentioned for inftance will change to a perfect brown of a very beautiful fhade, if paffed through a mordant of alum and falt, and boiled a fecond time with madder. Mr. Vogler obtained a very fine

 black,

black, by galling thread and cotton impregnated with ſalt of lead, and then putting them into a ſolution of ſulphat of copper, and boiling them in a bath of logwood.

Cobalt diſſolved in the nitro-muriatic acid produced a very pleaſant colour nearly reſembling a very ſaturated violet. A ſolution of ſulphat of copper gave a bad lilac. Verdegris diſſolved in vinegar produced the ſame effect.

The nitrat of copper produced a much more beautiful and ſaturated colour.

Thread and cotton that have received the mordant of ſulphat of copper or iron, take in the madder bath a dirty dull violet colour.

Mr. Vogler having added the alkaline ſolution of arſenic above mentioned, to a moderately ſaturated ſolution of ſulphat of copper or iron, produced a turbid mixture which effervesced, and he rendered it tranſparent by adding ſulphat of iron. Thread and cotton impregnated with this preparation received a beautiful ſaturated puce colour which penetrated them deeply.

The nitrat and muriat of iron produced a better effect than the ſulphat and acetite, they afforded a beautiful well ſaturated violet colour. The alkaline ſolution of arſenic mixed with earthy and metallic ſalts generally render

them better mordants for all colours. This likewise renders the effect of the mordants into which it enters more lasting, so that the stuff impregnated with it many years before, may be dyed without disadvantage, a circumstance we do not remark respecting any other mordant, excepting a solution of tin. Sulphat of zinc afforded a weaker violet than sulphat of copper. Sulphat of lime and calcareous nitrat produced no effect. Sulphat of manganese discovered some though but little action. Mr. Vogler remarks, that it is necessary always to rinse the cotton and thread when they come out of a mordant ; if this precaution be neglected, a weak colour only is frequently obtained, where a strong one was expected, because the particles of the mordant dispersed through the bath, combine with the colouring particles and are precipitated with them ; this precaution is especially necessary, when we dye with substances which do not contain much colouring matter.

Mr. Vogler prepares the madder bath in different ways. He put three drams of madder into from sixteen to eighteen ounces of water, he macerated it for twenty-four hours, then boiled it for a quarter of an hour, introduced the thread and cotton, and boiled them for half

a quarter of an hour, he afterwards washed them in two or three waters, and then dried them in the shade; he remarks that by long boiling, the colour of the stuff is taken away and destroyed.

Fresh urine substituted for water affords more lasting colours, but in summer it is apt very soon to become putrid, so as to render the infusion incapable of giving the dye.

One dram of sheep's dung or *album grecum* produced the same effect as the urine.

Three drams of muriat of soda or one dram of ammoniacal muriat produced a fuller but less bright colour. Sulphat of pot-ash and nitre had no effect.

Three drams of white sugar afforded a more beautiful and saturated colour; on the addition of four drams of long pepper, it was found to have become more capable of resisting the nitric acid.

One dram or one and a half of starch or gum arabic thrown into the bath just as it begins to boil, and before the cotton is put in, gives a finer and more saturated colour; one dram of fenugreek seed produced very nearly the same effect.

If in the beginning of the digestion four drams of spanish pepper are added, we obtain from

from the liquor colours that are more durable than the preceding, eſpecially if we afterwards add three drams of common ſalt.

From one ounce to one ounce and a half of glue in the ſtate of jelly thrown into the liquor as the ebullition commences, affords a particularly beautiful full colour, and the addition of three drams of common ſalt not only renders the colour more laſting, but preſerves the infuſion from becoming putrid.

The moſt beautiful colour of all, however, is obtained by mixing four drams of ox gall with the decoction, but at the ſame time it muſt be obſerved, that this colour is more eaſily deſtroyed by the nitric acid than any other.

All the madder baths except thoſe prepared with urine, glue, and animal dung, may be preſerved for a long time without loſing their power. Mr. Vogler kept ſome till they became mouldy and fœtid, and yet they dyed very well; nay he obſerves that they produced more durable colours, or at leaſt, colours which reſiſted the action of the nitric acid more powerfully.

On putting from thirty-ſix to forty grains of cryſtals of tartar into the bath, juſt as the linen was thrown in, the colour produced, was found capable of reſiſting the nitric acid. The

ſulphuric,

sulphuric, nitric, and muriatic acids, in very small quantity, produced the same effect; in too large a quantity they weakened the colour and rendered it pale. One dram and a half of powdered alum made the colour finer, but not more durable; twenty-four drams of corrosive muriat of mercury, rendered it more obscure but more permanent. White arsenic employed in different proportions never occasioned the least change, though dyers frequently use it as well as orpiment, with a view of making the colour more durable.

In Mr. Vogler's experiments, cotton always took the colour better than thread, the difference however, was not very great, when he employed linen or hempen cloth that had been a little worn, and that had become soft to the touch, and when its texture was loose and the thread slightly twisted.

Mr. le Pileur d'Apligny gives a very minute description of the process employed at Rouen for dyeing cotton red; it is as follows:

The cotton must be scoured, galled with one part of galls to four of the cotton, after which it must be alumed with four ounces of roman alum to one pound of cotton, and an equal weight of water; to the solution of alum, one twentieth part of a solution of soda, consisting

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of half a pound of ſoda to a quart of water, muſt be added.

Some uſe only half the quantity of ſoda, and one ſixth leſs of water, which they replace by a ſolution of tartar and arſenic. Mr. le Pileur d'Apligny thinks theſe laſt ingredients counteract each other. We have ſeen by Mr. Vogler's experiments that tartar uſed with the mordant weakens the colour, and that arſenic was only uſeful when combined with an alkali.

Others add acetite of lead or ſaccharum ſaturni, or muriat of tin. Mr. le Pileur d'Apligny adviſes the addition of ſome vinegar to the acetite of lead, in order to prevent the precipitation which is formed, when it is diſſolved in water.

When the cotton is taken out of the mordant, it is ſlightly wrung with the pin, and dried; the colour is more beautiful as the drying is ſlow. They generally dye only twenty pounds of cotton at a time; it is better to dye even only ten, becauſe when too great a number of hanks are wrought in the copper, it is much more difficult to dye them equally.

A copper in which ten pounds of cotton are to be dyed, ſhould hold about two hundred and forty quarts of water, which muſt be heated: when

when almoſt too hot for the hand, ſix pounds and a quarter of good dutch grape madder are to be added, and carefully diſperſed through the bath. When it is well mixed with it, the cotton which has been previouſly put upon the ſticks and placed on the edge of the copper, is to be immerſed hank by hank. All the cotton being put into the bath, it is to be worked, the hanks on each of the ſticks being turned for three quarters of an hour, and the bath kept conſtantly at the ſame degree of heat without boiling. At the expiration of this time, the cotton is taken out and placed on the edges of the copper, a pint of the above ley of ſoda is to be added to the bath, the cotton is then to be returned into the bath, and boiled from twelve to fifteen minutes, laſtly, it is to be taken out and left to drain, wrung, waſhed in a ſtream of water, and wrung on the pin a ſecond time.

Two days afterwards, the cotton receives a ſecond maddering in the proportion of eight ounces to the pound, and is worked about as in the firſt maddering, with this difference, that no ley is added, and that well water is employed for the bath; this maddering being finiſhed, the cotton is left to cool, waſhed, wrung, and dried.

Mr.

Mr. le Pileur d'Apligny does not think this method of dyeing by two baths a good one, becaufe it requires more time and fuel, and becaufe the fecond maddering cannot furnifh much dye, the falts of the mordant having been exhaufted by the firft. He propofed another method, in which he fays feveral dyers have already fucceeded; it confifts in aluming the cotton twice, and then dyeing it by one bath only.

In order to render this red more lively, a quantity of warm water, fufficient to moiften the cotton, is put into a caldron or vat, into which about a pint of the ley is to be poured, the cotton is to be foaked in this bath, pound by pound, left there for a moment, taken out, wrung, and dried. According to Mr. le Pileur d'Apligny this operation is ufelefs, for as the red cotton is intended for making ftuffs, from whence it is neceffary to feparate the preparation when they are to be wrought, the colour of the cotton is at the fame time rendered more lively, becaufe it is paffed through warm water rendered more active by the addition of a little ley. When the ftuffs are taken out of this water, they are wafhed in a ftream, and fpread upon the grafs, where the red brightens more than it would do by any other operation.

The

The red in printed ſtuffs is likewiſe produced by madder, but it muſt be fixed by a mordant. Mr. Wilſon deſcribes that which is uſed for this purpoſe, as follows, in four pounds of hot water (ſome employ lime water) three pounds of powdered alum, and one pound of ſaccharum ſaturni, or acetite of lead, are to be diſſolved, this ſolution is put into a veſſel ſufficiently large to allow of the efferveſcence which takes place, and two ounces of powdered chalk, two ounces of pot-aſh, and two ounces of corroſive muriat of mercury, or corroſive ſublimate, are to be added. This mixture muſt be well ſtirred and ſuffered to ſettle, the clear liquor muſt then be decanted, or what is better, filtered.

With this liquor, coloured with the decoction of braſil wood, they print, and paſs the ſtuff through hot water, in which cows dung has been diffuſed, in order to take away the ſtarch or gum, uſed to give conſiſtence to the mordant, they then carefully waſh it, and put it into a madder bath. All the ſtuff becomes coloured, but that which has not been fixed by the mordant is deſtroyed, by alternately boiling with bran and expoſure on the graſs.

Mr.

Mr. Oberkampf uſes the ſame ingredients for the mordant, except that he does not put into it any corroſive mercurial muriat. We have ſeen by Mr. Vogler's experiments, that that metallic ſalt rendered the colour of the madder more durable, and at the ſame time deeper.

I ſhall here call to the reader's recollection that alum is decompoſed by acetite of lead, and that there reſults from the decompoſition an acetite of alumine, while the lead combined with the ſulphuric acid, forms an inſoluble ſalt, which remains in the ſediment. The alkali and the chalk ſerve to take up the ſuperabundant acid, which would weaken the colour of the madder, and give it a yellow tinge.

Mr. Wilſon directs the uſe of this mordant, which is known by the name of printers mordant, and which is the ſame which Mr. Watt refers to in the experiments above mentioned, relative to the dyeing cotton red; according to his proceſs it muſt be galled, dried, impregnated with the mordant, diluted with hot water, dried a ſecond time, maddered, waſhed, and dryed again.

The Adrianople red poſſeſſes a degree of brightneſs, which it is difficult for us to approach by any of the proceſſes hitherto mentioned,

tioned, it has likewiſe the property of reſiſting much more powerfully the action of different reactives, ſuch as alkalis, alum, ſoap, and acids. Mr. Vogler confeſſes that by his numerous proceſſes, he has not been able to obtain a red of a degree of permanency equal to that of the Adrianople red, though he has much excelled in this reſpect the falſe Adrianople reds uſed for Siameſe (ſiamoiſes) and other red ſtuffs. It is neceſſary to remark, that ſoap ſuds weakens and deſtroys the moſt durable madder colours, even that of the Adrianople cotton; hence it appears, that we ought as much as poſſible to be ſparing in the uſe of ſoap, in the waſhing of thread and cotton of this colour; the only difference between the true and falſe Adrianople red, is this, that the one reſiſts theſe influences much longer than the other. Aqua fortis or dilute nitric acid, is according to Mr. Vogler the beſt and moſt expeditious teſt, for diſtinguiſhing the true Adrianople red from the falſe. If we immerſe a thread of the latter dye in it, it ſoon becomes pale, and in leſs than a quarter of an hour white, while the true Adrianople red will remain in it for an hour without any alteration, and indeed never entirely loſes its colour, which acquires an orange hue.

The

The Adrianople red, which for a long time came to us by our Levant trade only, excited the induſtry of our artiſts, but their attempts were for a long time fruitleſs, or their ſucceſs confined to a very few manufactories. The Abbé Mazeas publiſhed ſome experiments which threw conſiderable light on this kind of dye, and government, from the information it received, publiſhed in 1765 an inſtruction under the title of *A memoir containing the proceſs for dyeing ſpun cotton of the ſame ſcarlet red as that of the Adrianople cotton.* We find the ſame deſcription in Mr. le Pileur d'Apligny's treatiſe, but the proceſs has not ſucceeded completely: the fault ſeems principally to have conſiſted in making the alkaline ſolution too ſtrong. The alterations made in different manufactories, with more or leſs ſucceſs, have been kept ſecret. For the following deſcription I am indebted to Mr. Clerc, who has the management of a manufactory at Vaudreuil, and who has ſent me a pattern of his cotton, which is dyed of a beautiful and durable red.

Process for the Adrianople or Turkey Red.

When a hundred pounds of cotton are to be dyed, we muſt begin by ſcouring it well. This operation conſiſts in boiling the cotton in a ley of ſoda, marking one degree of the areometer, to which is commonly added the remainder of the bath which has been employed for paſſing the cottons through, for *the white preparation* (en l'apprêt blanc) which is called *ſickiou.*

In order to ſcour the cotton properly, and prevent it from entangling, a cord is paſſed through three hanks (the hank is compoſed of four knots (pentes) each of which weighs a quarter of a pound, making the hank equal to a pound) and it is thrown into the ley when it begins to boil; it is carefully immerſed, that it may not be ſcorched by the upper part of the caldron, which ſhould contain about one hundred and fifty gallons of water for a hundred pounds of cotton: the cotton is completely ſcoured when it ſinks of itſelf in the caldron; it is then taken out, and waſhed knot by knot in the river, wrung, and hung out to dry.

Second

Second Operation ; Bath with Dung.

A hundred pounds of Alicant ſoda (barilla) in coarſe powder, are put into a tub with a hole near its bottom, to allow the water to run into another tub placed under it ; ſeventy-five gallons of lixivial water are poured on the ſoda in the upper tub ; when the water which has run into the lower one marks two degrees of the ſoap-makers areometer, it is proper for the bath with dung, which is made in the following manner.

Twenty-five or thirty pounds of ſheeps dung are mixed with the above ley in a large earthen veſſel, and ſtirred with a wooden peſtle, then paſſed through a hair ſieve placed over the vat in which the bath is to be prepared, twelve pounds and a half of Provence olive oil are then poured into the vat, and kept conſtantly ſtirring with a rake, that it may be perfectly mixed with the ley and the dung ; the ſoda ley is poured upon it, nine buckets of water (each equal to four gallons) are commonly required for a hundred pounds of cotton. The bath being thus prepared is in a proper ſtate to receive the cotton. For this purpoſe, ſome of the bath is taken in a wooden bowl, and poured into

an earthen pan ſet in brick-work at a proper height for working. A hank of cotton is taken and well wrought with the hands; it is frequently taken up and turned in the pan, and then hung upon a wooden hook fixed to the wall; it is ſlightly wrung out, and thrown upon a table, and the ſame operation is repeated with each hank. The table upon which the cotton is thrown ought to be raiſed eight or ten inches from the ground. A workman takes a hank in each hand, and ſtrikes it on the table to ſtretch the threads; he turns it three times, and then makes a ſmall twiſt to form a head for the hank and lays it upon the table: not more than three hanks ſhould be placed one upon another, as too great a weight would ſqueeze the bath out of the under hanks. The cotton ought to remain ten or twelve hours on the table, and then be hung out to dry.

Third Operation; Bath with Oil, or White Bath.

Ley of ſoda alſo at two degrees of the areometer is taken, and after the vat in which the bath with dung was made has been well cleaned, twelve pounds and a half of olive oil are put into it, and the ley of ſoda added while it is kept conſtantly ſtirred with a rake, in order to mix

mix the oil completely. This bath ought to resemble thick milk, and that it may be good, it is neceſſary that the oil ſhould not riſe to the ſurface; ſome of this bath is then put into the pan, and the cotton dipped hank by hank, as in the former operation; it is thrown on the table, and beat upon it, which is called *crêper*; it is left there till the next day and then hung out to dry. For this bath about eight buckets of ley are required.

Fourth Operation; firſt Salt.

Freſh ſoda is added to the remainder of that firſt put into the tub, if the water poured upon it has not attained three degrees. For this operation eight buckets of ley are poured into the vat upon the remains of the white bath, and the cotton is paſſed through it in the ſame manner as before. This operation is called *giving it the firſt ſalt* (donner le premier ſel). The ley being at three degrees.

Fifth Operation; ſecond Salt.

The cotton is paſſed through a ley of ſoda at four degrees, the working being conducted as before deſcribed.

Sixth Operation; third Salt.

The cotton is paſſed through a ley of ſoda at five degrees.

Seventh Operation; fourth Salt.

The cotton is paſſed through a ley of ſoda at ſix degrees, the ſame precautions being obſerved, and then carried out to be dried on very ſmooth poles; when dry, it is taken to the river to be waſhed in the following manner.

Eighth Operation.

The cotton muſt be firſt ſoaked in the water, then taken out and put upon the horſe (bayard) to drain; water is repeatedly thrown on it, that it may be well ſoaked, and an hour after it is waſhed knot by knot, to free it completely from the oil, which is abſolutely neceſſary to its taking the galling well; it is then wrung with the jack and pin, and ſtretched upon the poles to dry: the cotton when thus waſhed ought to be of a beautiful white.

Ninth Operation; galling.

For the galling, we muſt chooſe good galls in ſorts (a term employed in commerce to denote

denote black and white galls mixed together in equal quantities) and having bruiſed them, put for each hundred pounds of cotton, twelve pounds and a half into a copper, and boil them in ſix buckets of clear river water. Three hours are generally required to boil them ſufficiently; we perceive that this is accompliſhed when they break between the fingers like *boullie*; three buckets of cold water are then added, and the whole paſſed through a very cloſe hair ſieve, ſqueezing with the hand what has not paſſed through, in order to ſeparate all the reſinous particles. When the water has ſettled and become clear, the galling is to be performed in the following manner.

Nine or ten quarts of the galling is poured into an earthen pan ſet in the wall at a height convenient for working, and the cotton is dipped in it by ſeparate hanks, working it well with the hands; it is then wrung with the pin, and carried out to be dried as faſt as it is dipped, a precaution eſſentially neceſſary to prevent the cotton from growing black.

When the cotton is thoroughly dried we proceed to the aluming, in the following manner.

Tenth Operation; aluming.

The copper in which the decoction of galls was made being well cleaned, eight buckets of river water and eighteen pounds of roman alum are put into it, and the alum dissolved without boiling; when the solution is complete, half a bucket of soda ley at four degrees of the areometer is added, and the cotton then wrought in it hank by hank as in the galling; it is then spread out to dry, and afterwards washed from the alum as follows.

Eleventh Operation; washing from the Alum.

Having left the cotton to soak and drain for an hour upon the horse, each hank is washed separately three times, wrung with a pin, and carried to the tenter ground.

Twelfth Operation (remonter sur galle.)

This operation consists in a repetition of the former ones. A white bath is prepared similar to that described in article 3; twelve pounds and a half of good Provence oil are put into a vat, and eight buckets of ley, at two degrees of the soap-maker's areometer, added to it, and

and the bath being well ftirred, the cotton is dipped in the manner defcribed in article 3.

Thirteenth Operation; firft Salt.

The cotton after being well dried is dipped in a ley at three degrees.

Fourteenth Operation; fecond Salt.

After the cotton has been well dried, it is dipped in a ley at four degrees.

Fifteenth Operation; third Salt.

When the cotton is again dry, it is dipped in a ley at five degrees, and this concludes the dips: after being dried, it is wafhed, galled, and alumed, with the fame proportions and attention to the fame circumftances as in articles 9, 10, and 11: the cotton has now received all the preparations neceffary for taking the dye, and ought to be of the colour of the bark of a tree. A very effential circumftance to be attended to, is, never to dip the cotton until it is perfectly dry, otherwife we run the rifk of rendering the colour fpotted. When the cotton is hung out upon the poles, it muft be frequently fhaken and turned to make it dry uniformly.

Sixteenth

Sixteenth Operation; the dying.

A copper of an oblong ſquare form is generally employed, which ought to be capable of holding about one hundred gallons, in which quantity twenty-five pounds of cotton may be dyed at once. The proceſs for dyeing is begun by filling the copper with water within four or five inches of the brim, and pouring in a pailful of bullocks blood, or what is ſtill better when it can be procured, ſheeps blood (this is equal to about five gallons) and then adding the lizary. When we wiſh to obtain a fine bright colour, which penetrates, and has a good body, we commonly mix ſeveral kinds of lizary together, as one pound and a half of lizary of Provence, half a pound of lizary of Cyprus; or if theſe cannot be had, a pound of that of Provence, with as much of the lizary from Tripoli or Smyrna, allowing always two pounds for one of cotton. When the lizary is in the copper it is ſtirred with the rake, to break the clods or lumps, and when the bath is warm, the cotton is put in on ſkein ſticks, two hanks commonly on each; care muſt be taken to immerſe it properly, and to turn the cotton on the ſkein ſticks by means of a pointed ſtick paſſed along them within the hanks. This proceſs

cess is continued for an hour; and when the copper begins to boil, the cotton is taken off the skein sticks, and immersed in it, each hank being suspended by means of a cord passed through it, to sticks supported over the copper. The cotton ought to boil about an hour, in order to extract all the colouring matter from the madder. There is also a method of discovering when the colour is extracted, by the formation of a white froth on the copper. It is now taken out, and washed knot by knot at the river, wrung with the pin, and dried.

Seventeenth Operation; brightening.

Soda ley at two degrees is poured into the copper used for scouring, which should hold a hundred and fifty gallons of water, and it is then filled within ten or twelve inches of the brim; four or five pounds of olive oil are then added, and six pounds of white Marseilles soap cut very small; it is kept stirring until the soap is dissolved, and when the copper begins to boil, the cotton is put in, a cord being previously passed through it to prevent its being entangled: the copper is then covered up, and stopped with rags, loaded and made to boil gently for four or five hours; the cover being now taken off, the cotton should appear finished,

and

and of a beautiful red. The cotton muſt not be taken out of the copper for ten or twelve hours, becauſe it improves in the bath and acquires a much greater degree of brightneſs.

It muſt be well waſhed knot by knot, and dried, and the operation is complete.

I am in the habit of giving my cottons a dip after they have become quite dry; I make a ſolution of tin in aqua fortis, taking for a hundred pounds of cotton three or four pounds of aqua fortis at twenty-ſix degrees [d], to which I add an ounce of ſal ammoniac for each pound, and then diſſolve in it ſix ounces of fine tin in grains; I add to the bath a pound and a half of mineral cryſtal; I then dilute the mixture with eight buckets of water, and dip my cotton; it muſt then be waſhed; this dip gives the cotton a very fine fire (feu).

N. B. Only the reſidua of the firſt preparations are to be put into the ſickiou; thoſe which remain after the cotton has been galled are of no uſe, and muſt be thrown away.

Mr. Gren has publiſhed ſome experiments which throw a great deal of light on the

[d] To diſtilled water as 1220 to 1000. T.

theory

theory of the Adrianople red [e]. He took two ounces of ſpun cotton, on which he poured freſh oil, and left it to ſoak for fifteen days, taking care to work the cotton well with it from time to time; he then ſqueezed out the oil as much as poſſible, and put the cotton into a boiling ſolution of barilla. After boiling it for half an hour, he poured out the ley which had a milky appearance, and ſupplied its place with freſh urine, in which he boiled the cotton a quarter of an hour; but he has aſcertained, that water may be ſubſtituted for the urine. He made a decoction with half an ounce of alum and two drams of ſumach, and put the cotton which had been well waſhed into it while boiling hot, and kept up the ebullition for an hour: after which he let it cool, and kept the cotton in it twelve hours; when taken out of this bath, it was dried in the ſhade, waſhed in cold water, and dyed with a decoction of half an ounce of madder: he choſe whole roots of madder the moſt ſlender he could find, cut them into ſmall pieces, and pounded them. He left the cotton to grow cold in the bath. When waſhed, it ſhewed a very fine colour, which differed from the true

[e] Crell neueſte entdeckungen, vol. iii.

Turkey

Turkey red cotton only in luſtre, which it did not poſſeſs in ſo high a degree, but it ſuſtained the ſame proofs; thus it retained its colour after being waſhed in boiling water; the brightneſs of the colour was increaſed by waſhing in a cold ley of aſhes; vinegar did not change it; expoſure to the ſun and air for three weeks produced no ſenſible alteration in it.

Ground madder of a middling quality, produced under ſimilar treatment, a dirty brown colour without any brightneſs; but Zealand madder of a good quality produced a colour ſimilar to the former.

The addition of fixed alkali, even in ſmall quantity to the decoction, produced a deeper colour. The addition of ſolution of tin gave the colour a more pleaſing hue.

Mr. Gren obtained only a bad colour which ſimple waſhing diſcharged, when he uſed pure or cauſtic pot-aſh inſtead of ſoda; but carbonat of pot-aſh ſucceeded as well as ſoda, when care was taken to ſqueeze out the oil from the cotton previous to its being put into the ſolution of the ſalt; if the oil was not ſqueezed out, the colour was but indifferent: whence he infers, that the alkali ought not to be ſo cauſtic as to deprive the cotton entirely of the oil, while at the ſame time, it ought to poſſeſs

ſufficient

ſufficient activity not to allow it to retain too much. Theſe experiments alſo evinced, that in order to produce a red ſimilar to that of Adrianople, it was neceſſary to chooſe the beſt kind of madder, and to prefer the whole roots, rejecting thoſe which are too old, too woody, or rotten. When he employed different kinds of the ground madder, he moſt commonly obtained a dark brown colour inſtead of a red, notwithſtanding all the attention he could employ in the coction.

I have repeated the proceſs of Mr. Gren, a great part of the numerous and intereſting experiments of Mr. Vogler, and have made ſome others of my own, of which I ſhall now give the reſults.

I have found, that the acetite of alumine formed by the mixture of alum, and the acetite of lead or ſalt of ſaturn, as already explained in the firſt part, was a better mordant than alum, for fixing the colour of madder, and that it was ſtill more efficacious, when it contained an exceſs of acid, as it is prepared for the printing of linens, and as Mr. Wilſon directs.

Alum ſaturated with pot-aſh to ſuch a degree as to afford a ſlight ſediment, was alſo a much more efficacious mordant than alum, probably

for the ſame reaſon. Solution of arſenic in pot-aſh produced a ſimilar effect, and even ſeemed to be ſuperior.

Galling renders the colour more fixed and appears to darken it a little; yet galling is employed in the Adrianople proceſs. Galls cannot be mixed with madder, becauſe they prevent the extraction of its colouring part. I have always begun my proceſſes by galling, after having leyed the cotton.

Leying renders the cotton more diſpoſed to become ſaturated with colour.

I have made the ſame obſervation as Mr. Vogler, that mucilages and gums render the colour more fixed, but that glue in particular produced this effect: it combines with the alumine and the cotton, and thus imparts to the cotton the property of animal ſubſtances.

Complete exſiccation between each of the proceſſes is very uſeful; when the water is expelled, its attraction no longer oppoſes the combination or decompoſition of the mordant to which it proved an obſtacle. It appeared to me a matter of indifference whether the exſiccation was quick or ſlow, provided however it was not too rapid, becauſe of the cryſtallizable ſalts, the alum for example, for then, the ſolution exſudes before it is decompoſed

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and cryſtallizes on the ſurface; in which caſe the dyers ſay that it has run. This is probably the reaſon for directing that the exſiccations ſhould be conducted in the ſhade and not in the ſun.

I have found that long maceration and long continued boilings with the mordant were uſeleſs, and that it was ſufficient if the cotton was well impregnated with the mordant: It has appeared to me for example, that no greater effect is produced by repeating the aluming two or three times ſucceſſively, than by one operation properly conducted.

If only the ſaturation and permanency of the colour were attended to, we ſhould from my experiments begin by leying the cotton, galling, drying and ſoaking it in the mordant compoſed of alum, and the alkaline ſolution of arſenic, or in the ſaturated acetite of alumine; we ſhould then dry it, ſoak it in a ſolution of glue, dry and wet it, that it may not take the colour unequally, and laſtly, dye it in a madder bath, containing glue. If we add common ſalt to one of the firſt preparations, the dye is ſtill ſtronger (plus forte); but the colour obtained in this manner and by ſimilar proceſſes, is browner and much leſs bright than the Adrianople red.

 Of

Of the two proceſſes, by means of which I came neareſt the Adrianople red, without uſing a conſiſtent oil, the one was by employing as mordant, a ſolution in the nitric acid of the precipitate from alum by common pot-aſh; the other was by adding oxyd of tin to the madder bath. By this laſt proceſs, I obtained a red which might eaſily be confounded with that of Adrianople: I ſhall compare their durability hereafter.

I repeated the proceſs of Mr. Gren with ſucceſs, ſubſtituting galls for the ſumach; but the colour which I obtained, and which came very near the Adrianople red, withſtood the action of leys, ſoap, and the air, leſs powerfully.

We have ſeen that Mr. Vogler had not ſucceeded by impregnating the cotton with oil; and yet without a greaſy ſubſtance, we cannot obtain a colour like the Adrianople red. The inteſtinal liquor of ſheep employed in the Adrianople proceſs under the name of ſickiou, ſeems to act by means of the greaſe which it contains, and by a ſubſtance analogous to the ſeroſity and gluten found in all animal ſubſtances.

Mr. Pallas relates in the Peterſburg journal for 1776, that the Armenians, whom the troubles

troubles in Perſia obliged to retire to Aſtracan, dye Turkey red by alternately impregnating the cotton with fiſh oil and drying it, for ſeven days; that they have obſerved that other oils do not ſucceed, and that they do not even uſe the oil of all fiſh indiſcriminately, but chooſe that which becomes milky upon being mixed with an alkaline ſolution. After theſe repeated impregnations and exſiccations, they waſh the cotton and dry it: they then give it an aſtringent bath to which a little alum is added; they dye it in a madder bath with which calves blood has been mixed; finally, they digeſt it for twenty-four hours in a ſolution of ſoda. It would ſeem that Mr. Vogler had not remarked, that the cotton ſhould be deprived of the oil only to a certain degree by means of the ley.

The following obſervations prove that in the Adrianople red, the cotton has retained a little of the oil. A ſkein of cotton having been ſoaked in ſoap-ſuds and wrung ſlightly, was dried and then immerſed in a mordant of alum ſaturated with pot-aſh, afterwards dried, and dyed; it had only a well ſaturated madder colour; after two minutes boiling in weak ſoap-ſuds, it came out with the ſhade of

Adrianople red: its durability was not examined.

If cotton dyed with madder in any way be boiled for fome minutes in foap-fuds, it acquires a rofe colour (rofé); if it be then fqueezed, a greafy matter is preffed out, which has the colour of Adrianople red, and which fixes on white cotton. Mr. Œtinger has obferved [f] in 1764, that oil had the property of diffolving the colouring matter of the Adrianople red, fo that if it be moiftened with oil, its colour is communicated to white cotton when rubbed with it for fome time. He had thence concluded, that oil muft enter into the preparation of Adrianople red, and the Abbé Mazéas has long ago proved that the ufe of oil in that dye was indifpenfable [g].

The kind of madder employed has great influence on the colour produced. It appears abfolutely neceffary to employ that which is called lizary, in order to obtain a colour equal to the Adrianople red.

[f] Differt. de viribus radic. rubiæ tinct. antirachiticis a virtute offa animal. vivorum tingendi non pendentibus.

[g] Recherches fur la caufe phyf. de l'adhérence de la couleur rouge, &c. Mem. *des Sav. étrang*, tom. iv.

With

With respect to the choice of madder, we must recollect that Messrs. d'Ambourney and Beckmann recommend the use of fresh madder; but it is generally supposed that it gives a more beautiful colour when kept for a year or two before it is used, and Mr. Guhliche says, that the old madder gives a colour nearly as beautiful as lizary. There are cases perhaps in which the use of fresh madder would be advantageous; the choice of the young roots would certainly be proper.

Having exposed for a long time to the inclemencies of the weather, the cotton which I had dyed with the addition of oxyd of tin to the madder bath, that, for which the solution of alumine in nitric acid had been employed as mordant, and a pattern of Adrianople cotton; the colour of the first remained longest without any sensible change; at last however it acquired a yellow hue; the second acquired a yellowish tinge sooner; the colour of the third was impaired soonest, but it did not change its hue (ton).

From this experiment it follows, that we may consider in cotton dyed with madder, its power of resisting the action of the air for a long time, or that of resisting alkalis or soap. This last can only be obtained by means of

oils and greafe, but the firft depends principally on the mordants employed, and the number of dryings. It is therefore proper, independant of the beauty of the colour, to employ proceffes fimilar to that of Adrianople, for fuch ftuffs as are to be fubjected to leying or frequent wafhing with foap.

Mr. Wilfon makes an obfervation which is worthy of attention. He fays that ftuffs made of cotton, which has not been fpun by Mr. Arkwright's machines, cannot be dyed by the Adrianople procefs, becaufe the filaments of the cotton are made to briftle up (fe hériffent) in the numerous operations of this procefs; but that thefe filaments preferve their parallelifm much better when the cotton has been fpun and carded by thefe machines, and that the ftuffs can then undergo the fame operations without injury to their texture [h].

But as colours which fuftain the action of the air as well as the Adrianople red, may be obtained by fhorter proceffes, and as cotton ftuffs are not intended to be fubmitted to leying and frequent wafhing, proceffes analogous to fome of thofe defcribed above, may frequently be employed with advantage.

[h] An effay on light and colours, &c.

One circumſtance which I ought not to omit, is that the oxygenated muriatic acid repreſented the action of the air on the madder reds expoſed to its influence, indicating the patterns which would reſiſt its action moſt powerfully; while the nitric acid on the contrary indicates the cotton dyed in the Adrianople manner, by giving it a yellow colour, as Mr. Vogler has obſerved [i]; this effect ſeems to depend on the combination of the animal oil with the cotton, to which, as to all other animal ſubſtances, the nitric acid gives a yellow colour, by deſtroying the proper colour of the madder: it is this combination of animal oil with the cotton which forms the diſtinguiſhing characteriſtic of this ſpecies of dye: a different kind of oil might produce a bright colour, but probably it would not be ſo durable.

I have alſo tried the oxyd of tin in dyeing wool. The decoction of madder acquires a more clear and lively red by the addition of this oxyd; its colouring particles became fixed much more quickly and more abundantly, upon

[i] I believe that Mr. Beckmann made this intereſting obſervation before Mr. Vogler. *Phyſical Æcon. Bibliotheck.* vol. iv.

cloth which had been prepared by a decoction of alum and tartar in the ordinary manner. The cloth came out of the dye bath of a much more saturated and beautiful red, than a similar pattern dyed with an equal weight of madder, without oxyd of tin; the advantage however does not appear to me so great, as to render the process worthy of being commonly employed.

Oxyd of zinc used instead of tin, produced a fine orange colour in the cloth; oxyd of lead a dull brick colour; that of iron had no sensible effect.

The above observations on madder may admit of numerous applications, in the very extensive and various uses for which it is employed, especially in the dyeing of cotton and linen. It is a substance which merits particular attention upon account of the advantages it may afford by its cultivation.

CHAP.

CHAP. III.

Of Cochineal.

COCHINEAL was at firſt ſuppoſed to be a grain, but naturaliſts ſoon diſcovered that it was an inſect. It is brought to us from Mexico, where the inſect lives upon different ſpecies of the opuntia. The body of the female is flat on the belly and hemiſpherical on the back, and marked with tranſverſe wrinkles. The ſkin is of a dark brown; the mouth is a tubular point which iſſues from the ſide of the thorax: it has ſix very ſhort brown legs and no wings; the body of the male is rather long, of a deep red colour, and covered with two wings extending horizontally, and croſſing a little upon the back; it has two ſmall antennæ on the head, and ſix legs, which are larger than thoſe of the female; it has not a direct flight but flutters, hopping very ſeldom; its life, which is only of a month's duration, terminates by its amours; and the fecundated female lives a month longer, and dies after parturition: the female is ſometimes oviparous and ſometimes viviparous. The young females when brought forth diſperſe themſelves upon the

the joints of the opuntia, where they remain fixed by their trunk (trompe) till the end of their life.

Two ſorts of cochineal are gathered at Mexico; the ſylveſtris, there known by the ſpaniſh name *grana ſylveſtra*, and the fine, or *grana ſina*, called alſo Meſteque, from the name of a province of Mexico, and which are bred upon the nopal. The firſt is ſmaller, and covered with a cottonny down, which increaſes its weight with a ſubſtance which is uſeleſs in dyeing: an equal weight of it therefore gives leſs colour and is of a lower price than the fine cochineal; but theſe diſadvantages are perhaps compenſated by its being reared with greater facility, and at leſs expence, and even by the effects of its down, which enables it the better to reſiſt rain and ſtorms.

The coch. ſylveſt. when bred upon the nopal, loſes part of its tenacity, and ſome of its cotton, and acquires double the ſize it has on the other ſpecies of opuntia. It is therefore to be hoped that it would be improved by a continued attention to the rearing of it, and would approach more and more to the fine cochineal.

M. Thieri de Menonville was led by his patriotic ſpirit and perſonal courage, to expoſe himſelf

himſelf to imminent danger, in going to obſerve the mode of rearing the cochineal in Mexico, in order to obtain from thence that valuable production, wherewith he might enrich the colony of St. Domingo. He brought back with him both ſpecies of cochineal, and nopals, the kind of opuntia which affords the beſt food for theſe inſects.

Upon his return, he employed himſelf in the cultivation of the nopal and different kinds of opuntia, and in rearing the two ſpecies of cochineal; but death cut off that excellent citizen, and the fine cochineal ſoon periſhed.

When he returned to St. Domingo, he diſcovered the cochinilla ſylveſtris upon a kind of opuntia called *péreſchia*, or *patte de tortue*, which grows there. This diſcovery did not remain unprofitable: M. Bruley employed himſelf ſucceſsfully in rearing this ſpecies of cochineal; he communicated it to the cercle des Philadelphes [a], who do not loſe ſight of that object, and have publiſhed a poſthumous work of M. Thieri de Menonville, which contains very minute inſtructions with regard to every thing that reſpects the cultivation of the nopal,

[a] Now the Royal Society of Arts and Sciences at Cape François. T.

and the other ſpecies of opuntia that may be ſubſtituted for it more or leſs ſucceſsfully, for breeding or rearing the cochineal [b].

Two months after the females, which have been reſerved, are ſown upon the nopal, the young cochineals are obſerved to iſſue from them; and then is the proper ſeaſon for gathering them: they are killed by immerſion in boiling water. The hot iron plates or ovens which are ſometimes employed may injure the cochineal by being too hot. When taken out of the water, they are carefully dried by free expoſure to the ſun. They loſe nearly two thirds of their weight in drying.

When the fine cochineal is dry, it muſt be paſſed through a ſieve ſufficiently coarſe to allow it to go through, but capable of retaining the down and cotton of the larvæ of the males. Theſe are kept apart and ſold ſeparately, or with the cochinilla ſylveſtris.

Fine cochineal, which has been well dried and properly kept, ought to be of a gray colour inclining to purple. The gray is owing to a powder which covers it naturally, a part

[b] Traité de la culture du nopal & de l'education de la cochenille dans les colonies Françoiſes de l'Amerique précédé d'un voyage a Guaxaca; par M. Thieri de Ménonville. *Ann. de Chym.* tom. v.

of

of which it ſtill retains: the purple tinge proceeds from the colour extracted by the water in which it has been killed.

Cochineal will keep a long time in a dry place. Hellot ſays, that he tried ſome, one hundred and thirty years old, and found it produce the ſame effect as new.

It has been pretty generally ſuppoſed, that cochineal owes its colour to the nopal on which it lives, the fruit of which is red. But Mr. Thieri de Menonville obſerves, that the juice which ſupplies it with nutriment is greeniſh; and that it can live and propagate its ſpecies, on ſuch kinds of opuntia as do not bear red fruit.

The decoction of cochineal is of a crimſon colour, inclining to violet.

A ſmall quantity of ſulphuric acid made this liquor aſſume a red colour, inclining to yellow, and a ſmall quantity of a beautiful red precipitate was formed.

Muriatic acid produced nearly the ſame change in the colour, but no precipitate.

Solution of tartar changed the liquor to a yellowiſh red. A little precipitate of a pale red colour formed ſlowly: the ſupernatant liquor remained yellow, but on pouring in a little alkali, it became purple. The ſmall quantity

tity of precipitate was quickly diffolved by the alkali, and the folution was purple. Solution of tin formed a rofe-coloured precipitate with the yellow liquor.

Solution of alum brightened the colour of the infufion, and gave it a redder hue: a crimfon precipitate was formed, and the fupernatant liquor retained a crimfon colour, fomewhat reddifh.

Alum and tartar mixed, produced a brighter colour, more lively, and inclining to a yellowifh red. A precipitate was formed, but much lefs abundant, and much more pale, than in the preceding experiment.

Solution of tin produced a copious fediment of a beautiful red. The liquor remaining above it was as clear as water, and fuffered no change of colour on adding alkali.

Having poured in a folution of tartar, and after that, folution of tin, a precipitate of a rofe colour inclining to black was formed more quickly than in the foregoing experiment; and, though folution of tin in excefs was added, the fupernatant liquor remained a little yellow.

Solution of muriat of foda rendered the colour fomewhat deeper, but did not make the liquor turbid.

Ammoniacal muriat gave a purple tinge, without occafioning any precipitate.

Sulphat of foda, produced no perceptible change in the liquor.

Having boiled a little cochineal with half its weight of tartar, the liquor was more inclining to red, and had a colour much lefs deep, than that obtained from an equal quantity of cochineal without tartar: but the former gave a more abundant precipitate with folution of tin, and its colour was more rofy: fo that tartar favours the folution of the colouring part of the cochineal: for, though the colour of the folution is lefs deep, the precipitate produced from it by folution of tin, is of a deeper and more rofy hue. This experiment deferves notice, in judging of the influence of tartar in dyeing fcarlet.

Sulphat of iron formed a brown violet precipitate. The fupernatant liquor remained clear, with a tinge of feuillemort.

Sulphat of zinc formed a deep violet precipitate. The fupernatant liquor remained clear and colourlefs.

Acetite of lead produced a purple violet precipitate, lefs deep than the preceding. The fupernatant liquor remained limpid.

Sulphat

Sulphat of copper produced a violet ſediment, which formed ſlowly. The liquor remained clear, and of a violet colour.

If the extract which decoction of cochineal affords on evaporation be digeſted in alcohol, the colouring part diſſolves, and leaves a reſiduum of the colour of wine-lees, of which freſh alcohol cannot deprive it. This reſiduum, analyzed by fire, affords the common products of animal ſubſtances.

The alcohol of cochineal, leaves on evaporation, a tranſparent reſiduum of a deep red, which, when dry, has the appearance of a reſin. This alſo, if diſtilled, yields the products of animal ſubſtances; which ſhews, that the colouring matter is an animal production.

Yet the decoction of cochineal does not eaſily putrefy. I have kept ſome of it more than two months, both in an open veſſel, and in a bottle corked. At the end of that time, the former ſhewed no ſigns of putrefaction: the latter had a ſlight putrid ſmell. The firſt grew turbid in a few days, and left a brown violet ſediment on the filter: the ſecond preſerved its tranſparency a long time, and probably loſt it only from the effect of an incipient putrefaction, or rather of a ſlight combuſtion, produced by means of a little oxygen, probably united with the

the red particles of the cochineal. The colour of each had become crimſon: but that of the former was more weak, becauſe a greater part of the colouring matter had precipitated, in conſequence of the effects produced on it by the air, agreeably to the principles eſtabliſhed in the firſt volume.

I have compared the cochinilla ſylveſtris of Mexico, and ſome which had been cultivated at St. Domingo, and ſent over by Mr. Bruley, with the maſtique cochineal.

The decoction of the ſylveſtris has the ſame hue as that of St. Domingo. This inclines more to crimſon than that of the maſtique: but the precipitates obtained from it either by ſolution of tin, or by alum, are perfectly equal in colour to thoſe from the maſtique cochineal; and to theſe precipitates the ſtuffs with which they combine owe their colour.

To determine the proportion of colouring matter contained in decoctions of different cochineals, I employed oxygenated muriatic acid. Of each of the three cochineals above mentioned I boiled an equal weight for an hour, rendering the circumſtances with regard to each as nearly ſimilar as poſſible. Having filtered the decoctions, I poured them into ſeparate graduated glaſs cylinders, and added to them

 oxygenated

oxygenated muriatic acid, from the ſame bottle, till they were all reduced to the ſame yellow hue. The quantities of acid which indicated the proportions of the colouring matter were found to be nearly as follows: for the cochineal of St. Domingo, eight; for the ſylveſtris, eleven; for the maſtique, eighteen.

It appears, then, that the cochineal of St. Domingo is not only greatly inferior to the maſtique, but even to the ſylveſtris of Mexico; and in fact it is much ſmaller, and more downy; but theſe diſadvantages ought not to abate the zeal of thoſe who are engaged in its cultivation.

The obſervations of Mr. Thieri de Menonville have already proved, that the cochinilla ſylveſtris loſes its down, and increaſes in ſize, by a ſucceſſion of breeds carefully attended to, though at firſt he was obliged to uſe nopals not come to the proper growth. There is every reaſon to hope therefore, that the St. Domingo cochineal may, by aſſiduous care, be brought to equal, or perhaps ſurpaſs the ſylveſtris of Mexico: but ſhould it always remain inferior with reſpect to the quantity of its colouring matter, this would be by no means a ſufficient reaſon to neglect a ſubſtance ſo valuable in dyeing.

It

It has been feen, that the cochineal of St. Domingo is not inferior to the maftique, as to the quality of its colour. If then, the down with which it is covered proves detrimental, in operations on a large fcale, to the beauty of fcarlet, the luftre of which is fo eafily injured, it might be advantageoufly employed either for fcarlet in half grain, or for crimfon, and other fhades, which are lefs delicate than that, which is the brighteft of all colours.

To form an idea of the utility of which cochineal may be to St. Domingo, poffeffed of fo many rich productions, is difficult. Mr. Thieri de Menonville confiders it as a valuable refource for thofe parts of the ifland, the unfruitful foil of which is not adapted to the other produce; and for thofe colonifts who are unable to fupport the expence attending the cultivation of other crops. Mr. Bruley fpeaks ftill more favourably of the advantages to be expected from the culture of cochineal: but the cercle des Philadelphes is more referved, and thinks, that the point is not yet to be decided upon.

The attempts that have been made deferve fo much the more to be purfued and encouraged, as they have for their object an important branch of commerce, and as enlightened in-

duſtry has great advantages over ignorant indolence. It will be found leſs difficult perhaps to naturalize cochineal, at leaſt in hot countries, than it was to naturalize ſilk-worms.

A diſtinguiſhing characteriſtic between cochineal and madder, may be obſerved in the manner in which they are acted on by reagents. Both receive a yellow colour from acids: but if the colouring matter of cochineal be ſeparated by a ſubſtance which precipitates it from the acid liquor, it reappears, with its natural colour little altered; whilſt that of madder, treated in the ſame manner, retains a yellow or fawn tinge. Hence mordants abounding in acid, as ſolution of tin, are much more ſucceſsfully employed with cochineal than with madder. The cauſe of this probably is, that the colouring matter of madder united with oxyd of tin retains a portion of acid, whilſt that of cochineal combined with it retains none, or a much ſmaller quantity.

Carmine is the lake obtained from cochineal by means of alum: but when the cochineal is mixed a certain proportion of Autour, a bark brought from the Levant, of a colour paler than cinnamon, and in general chouan, a yellowiſh green ſeed, of an unknown plant, likewiſe brought from the Levant, is alſo added.

It

It is probable, that theſe two ſubſtances furniſh with alum a yellow precipitate, which ſerves to brighten the colour of the cochineal lake, as a yellow colouring matter gives ſcarlet the colour of fire. Carmine was formerly prepared from kermes, whence its name is derived.

CHAP. IV.

Of Dyeing Scarlet.

SCARLET is the fineſt and moſt ſplendid colour in the art of dyeing. The ſame taſte with reſpect to the ſhade that is preferred does not always prevail: ſometimes it is required to be of a deeper and more perfect red, at others, to incline more or leſs to the colour of fire.

We cannot expect to obtain the deſired ſhade from the preciſe proportions preſcribed in the proceſſes, becauſe the quantity of colouring matter contained in different kinds of fine cochineal varies, and ſtill more, becauſe the ſolutions of

tin employed, may differ confiderably from each other: but it is eafy to afcertain, by trials on a fmall fcale, the proper proportion of ingredients to be ufed for obtaining a particular fhade; and if the pieces dyed be found to go beyond the point, or fall fhort of it, it is difficult to bring them to it. I fhall firft defcribe the chief of the proceffes known, and afterwards endeavour to lay down principles by which the colour may be modified at pleafure.

As I have already treated at length of the folution of tin, called by dyers *compofition*, on this fubject I fhall refer to the third fection of the firft volume. For the proceffes alfo, by which hard water is rendered more pure, the chapter in which they are defcribed may be confulted; the water employed for this dye requiring particular attention.

Dyeing fcarlet is performed at two operations: the firft is called the boiling; the fecond, the finifh or reddening (rougie.)

For the boiling defigned for dyeing a hundred pounds of cloth, fix pounds of pure tartar are thrown into the water when a little more than warm. The bath is ftirred brifkly, and when it is a little hotter, half a pound of powdered cochineal is added, and well mixed. A moment after, five pounds of very clear folution

ſolution of tin are poured in, and carefully mixed. As ſoon as the bath begins to boil, the cloth is put in, and moved briſkly for two or three turns, after which it is moved more ſlowly. When it has boiled a couple of hours, it is taken out, aired, and carried to the river to be well waſhed.

To prepare the ſecond bath, which is the reddening, the boiler is to be emptied. When the bath is ready to boil, five pounds and three quarters of cochineal powdered and ſifted are put in. Theſe being carefully mixed, when after having ceaſed ſtirring, a cruſt, which forms on the ſurface, opens of itſelf, in ſeveral places, thirteen or fourteen pounds of ſolution of tin are poured in. If, after that, the bath riſe above the brim of the boiler, it is to be cooled by the addition of cold water.

When the ſolution is well mixed, the cloth is to be put into the bath, taking care to turn it quickly the firſt two or three turns. In this bath it is boiled for an hour, puſhing it down with a ſtick when the boiling raiſes it up. It is then taken out, aired, and cooled; after which it is waſhed in the river, and dried.

The proportions of cochineal, and of ſolution of tin, put either into the boiling, or into the reddening, are not fixed. There are dyers,

who according to Hellot's account, ſucceed very well by putting two thirds of the compoſition, and a fourth of the cochineal into the boiling, and the remaining third of the compoſition, with the remaining three fourths of the cochineal, into the reddening. Hellot aſſerts alſo, that it does no harm to uſe tartar in the reddening, provided not more of it than half the weight of the cochineal be put in; and it has appeared to him even to render the colour more permanent. This is at preſent the practice of ſeveral dyers. It has been ſeen, that tartar promotes the ſolution of the colouring matter, an effect that eſpecially occurs when it is ground with the cochineal, whence the reſiduum is more completely exhauſted. This conſideration is of leſs weight, when the operations are performed one after the other, becauſe then the colouring matter left in the reſiduum is employed in the ſubſequent operations. But we muſt not forget the effect the tartar has on the quality of the colour, to which it tends to give a roſy hue, as has been already ſeen.

Some dyers do not take the cloth out of the boiling, only refreſhing it, to make the reddening in the ſame bath, by pouring in an infuſion of cochineal, which they have made apart, and with

with which they have mixed the proper quantity of composition. In this way they save time and fuel; and they assert, that the scarlet is equally fine.

As scarlet is in general required to be very lively, and to approach the colour of fire, a yellowish tinge is given it by boiling fustic in the first bath, or by adding a little turmeric to the cochineal. The yellow tinge might be obtained by increasing the quantity of composition: but this has the inconvenience of rendering the cloth harsh, and even of preventing the colouring matter from fixing in it in a certain quantity. Thus, though neither fustic nor turmeric gives a permanent colour, it is better perhaps to use them in small quantity, than to add too much solution of tin. That these ingredients have been used is discoverable by cutting the cloth, the inside of it appearing in that case yellow; whilst in the common processes the cochineal does not penetrate the cloth, leaving it internally white, when it is said to *cut*.

In dyeing scarlet it is of advantage to use tin boilers, because the acid employed attacks copper, and the solution it forms with it may injure the beauty of the colour. But as these are difficult to make of any considerable size,

and

and are liable to melt, if the workmen forget to withdraw the fire before emptying them, many dyers use copper ones. It is necessary however, to keep these very clean, not to let the acid liquor remain in them, and to prevent the cloth dyed in them from touching the copper, by means either of a net, or of an open-work wicker basket.

Scheffer directs for the boiling, an ounce and a half of solution of tin, with an equal quantity of starch, and as much tartar, to every pound of cloth. He observes, that the starch serves to render the colour more uniform; and he directs, to throw into the water, when it boils, a dram of cochineal, to stir it well, to boil the wool an hour, and afterwards to wash it. The wool is then to be boiled half an hour in the reddening bath, with half an ounce of starch, three quarters of an ounce of solution of tin, half an ounce of tartar, and seven drams of cochineal.

It appears, that Scheffer employs a much smaller quantity of solution of tin than Hellot: but his solution, the manner of making which has already been given, contains much more tin.

Mr. Poerner describes three principal processes, according as the shade of the scarlet is

to

to be more or leſs deep, or more or leſs inclining to orange. He puts no cochineal into the boiling, which he compoſes of one ounce ſix drams of tartar, and an equal weight of ſolution of tin, added after the tartar is diſſolved, for every pound of cloth. After it has boiled a moment, he puts in the cloth, and lets it boil two hours.

For the reddening of the firſt proceſs, he uſes two drams of tartar, and an ounce of cochineal; afterwards pouring in gradually two ounces of ſolution of tin.

For the reddening of the ſecond proceſs, he uſes the ſame quantity of cochineal, and two ounces of ſolution of tin, without any tartar.

For that of the third, he directs two drams of tartar, an ounce of ſolution of tin, and two ounces of common ſalt, with the above quantity of cochineal.

The ſcarlet of the firſt proceſs is of the deepeſt ſhade; that of the ſecond is leſs full, but more lively; that of the third is ſtill more bright and pale.

Tartar, as has been ſeen, gives a deeper and more roſy hue to the colouring matter of cochineal precipitated by ſolution of tin. It moderates the action of the nitro-muriatic acid,

which tends to give ſcarlet an orange caſt, though this orange caſt is not to be ſeen in the precipitate produced by the ſolution of tin, which is on the contrary, of a fine red. It is probable, that the ſolution of tin gives ſcarlet an orange tinge, by means of the action the nitro-muriatic acid exerts on the wool, which, as well as all other animal ſubſtances, it has the property of turning yellow.

Thus by putting more or leſs tartar into the reddening, a deeper and fuller ſcarlet may be obtained; and, on the contrary, the ſcarlet may be rendered more inclining to orange, by omitting this ingredient.

But the ſolution of tin may alſo influence the colour, according to the proportions of tin and ammoniacal muriat it contains. On this ſubject I have made various experiments.

A ſolution of tin made with ſixteen parts of nitric acid, at thirty degrees of Baumé's areometer, two parts of ammoniacal muriat, and three parts of tin, gave a leſs lively and ſomewhat deeper colour, than a ſolution in which the acid and ammoniacal muriat were in the ſame proportions, but which contained only two parts of tin. Theſe laſt mentioned proportions ſucceeded with me beſt of many

which I tried. I mix with the ſolution four parts of water. Putting only half a part of muriat of ammoniac, the colour was more bright, and inclining to orange. In fine, by uſing a ſolution of murio-ammoniacal ſalt of tin, which contained near half its weight of oxyd of tin, and adding to the ſolution a little muriatic acid to prevent the precipitation of the metal, I obtained a crimſon colour: but on adding tartar in the reddening, the cloth took a beautiful deep red, which reſiſted the oxygenated muriatic acid better than common ſcarlet. It is to be obſerved, that when this ſalt is uſed, the bath is exhauſted more readily and more completely than with the common ſolution of tin.

Scarlet may be brightened by common ſalt; and the colour will at the ſame time penetrate deeper, and leave leſs cut. Muriat of ammoniac alſo renders the colour more bright and pale, but it carries the effect too far.

I cannot explain the reaſon why common ſalt, which deepens a little the colour of infuſion of cochineal, and produces the ſame effect on colours in general, ſhould diminiſh the intenſity of ſcarlet.

Mr. Poerner obſerves, that the proportion of common ſalt he directs is the greateſt that can

can be employed ; and that a more agreeable ſhade, though lighter, will be obtained, if leſs be uſed. He ſays, that the addition of five ounces of white ſugar to the ingredients of the ſecond proceſs will produce a finer colour, which is always lighter than that of the firſt proceſs. He aſſerts, that a more pleaſing and more permanent colour will be obtained, if the cloth be left in the boiling twenty-four hours after it is cold.

If the ſcarlet which has been juſt dyed be found to have too much of the orange caſt, this may be weakened by waſhing with hot water, eſpecially if the water contain any ſalt with an earthy baſe.

The reddening which has been uſed for dyeing ſcarlet is not exhauſted of its colouring matter, but ſtill contains a portion which varies in quantity according to the fineneſs of the powder, to which the cochineal was reduced, and the length of time it has been boiled. This bath retains alſo a portion of the mordants which were put in. As the nature of this reſiduum however, is not always the ſame, it would be illuſory to preſcribe the exact quantities of the ingredients to be added, to obtain from it any particular ſhades : experience, and the habit of performing the ſame proceſs, will

will easily guide an intelligent dyer: I shall confine myself therefore, to some general reflections.

If we have much cloth to dye scarlet, we may use for the boiling a reddening with which we have just dyed, taking from the ordinary quantity of cochineal as much as we suppose to be left in the bath, diminishing also the quantity of solution of tin. But if we would have a fiery colour, we must begin by boiling a bag of fustic, taking it out before adding the other ingredients.

After this the bath may be used, as soon as the cloth is taken out, for making pomegranate colour, boiling in it a bag of fustic. That which has already been in a bath, is fitter than new for this shade. As soon as this is taken out, some tartar and composition are put into the bath, which is well raked, and the cloth treated as for dyeing scarlet.

The bath may be used after this for capuchin colour (les capucines) boiling in it fustic, and adding tartar and solution of tin.

The preceding boiling may also be used for langouste, orange, cassis, gold colour, and jonquille, by boiling in it fustic, and adding a little cochineal, and more or less tartar, and solution of tin.

When

When all the cloths to be dyed have gone through the boiling, proceeding from the deepeſt colour to the lighteſt, they are to be paſſed through the reddening, proceeding contrariwiſe from the lighteſt to the deepeſt, adding more and more cochineal, and ſolution of tin, till we come to the pomegranate and fire colours. When it is come to the turn of the gold colour and jonquille, fuſtic is to be added, at leaſt if they were not finiſhed in the firſt bath, which as we ſhall ſee, may be done for ſome ſhades. For the gold colour and caſſis a little madder is to be added.

The colours of gold, caſſis, jonquille, and buff, may be made after the ſcarlet boiling, by adding for the former two, fuſtic, ſolution of tin, and a little madder; a little more fuſtic, and a little leſs ſolution of tin, for the firſt than for the ſecond. For the buff much leſs ſolution of tin muſt be uſed. A dun colour (coleur de biche) may be made after boiling ſcarlet without any addition. Le caffé au lait requires a little fuſtic and ſolution of tin, and a very ſmall quantity of madder: for le chocolat au lait, a little cochineal and tartar are added to the laſt mentioned ingredients.

For the boiling for cherry colours, a freſh bath compoſed of tartar and ſolution of tin, is

generally

generally ufed. Afterwards, for dyeing them, a reddening that has been ufed for fcarlet is employed, adding to it tartar, folution of tin, and a little cochineal. In boiling and reddening thefe, only half the time required for fcarlet is taken up: and in general the time is fhortened in proportion to the delicacy of the tint. For the boiling for rofe colour the reddening of cherry colour may be employed, and its reddening compofed of a little folution of tin, a little tartar, and a very little cochineal. The colour may be deepened by paffing the cloth through hot water when it comes out of the dye.

Flefh colour (couleur de chaire) is made after a reddening, by throwing away a little of the bath, and cooling it. It may alfo be made after a violet colour, by adding a little folution of tin. It muft boil but a fhort time.

Finally, the reddening from which fcarlet has been taken out may be ufed for grays that are to have a purple (vineux) caft; refrefhing the bath with the addition of galls, and afterwards a little fulphat of iron, or green vitriol.

It muft be obferved, that weak and delicate tints, as langouftes and orange colours, as well as lilacs, mauves, cherry, and rofe colours,

 have

have more bloom and freſhneſs when prepared in a ſingle bath, than when they have gone through both boiling and reddening. It is only neceſſary to put into the bath the proper ingredients. The cloth ſimply wetted, and impregnated with no mordant, fills itſelf with the colouring matter leſs readily, and more evenly. In this way too, time and fuel are ſaved.

From what has been ſaid, it appears, that for obtaining different ſhades of ſcarlet, and the colours derived from it, nothing more is neceſſary than to vary the proportions of cochineal, tartar, and ſolution of tin, and to add for the ſhades moſt inclining to yellow, fuſtic, for which other yellow ſubſtances are ſometimes ſubſtituted. Tartar ſerves to deepen the colour: ſolution of tin makes it incline to orange. For light ſhades the time of operating muſt be ſhortened.

CHAP.

CHAP. V.

Of Dyeing Crimſon.

ALL the proceſſes employed for obtaining the different ſhades of crimſon, from the deepeſt to the lighteſt, may be reduced to two. Either the ſhade of crimſon deſired is given to cloth previouſly dyed ſcarlet, or the cloth is dyed crimſon at once.

Alum, ſalts with earthy baſes in general, fixed and volatile alkalis, have the property of changing the colour of ſcarlet to crimſon, which is the natural colour of cochineal. Nothing is neceſſary therefore, than to boil cloth dyed ſcarlet for about an hour in a ſolution of alum, proportioned in ſtrength to the deepneſs of the colour deſired. But as other ſalts with earthy baſes have the ſame property, and water contains more or leſs of theſe ſalts, whence it gives a proportionate roſy tinge to ſcarlet paſſed through it, particularly if it be warm, the quantity of alum neceſſary to obtain a crimſon varies according to the nature of the water employed: nay, if the water be loaded with earthy ſalts, it will anſwer the purpoſe of itſelf, without the addition of alum. When

a piece of ſcarlet has any defeƈts it is made into a crimſon.

Hellot ſays, that he has tried ſoap, ſoda, pot-aſh, and cendre gravelée: that all theſe ſubſtances produced the crimſon deſired, but ſaddened it, and gave it leſs luſtre than alum: that ammoniac on the contrary produced a very good effeƈt, but, as it evaporates quickly, a conſiderable quantity muſt be put into the bath a little more than warm, a little ammoniacal muriat, or ſal ammoniac, and an equal quantity of common pot-aſh. In this method the cloth inſtantly took a very bright roſy colour. He aſſerts, that it heightens the colour ſo much as to render leſs cochineal neceſſary. Mr. Poerner, who gives the ſame proceſs, direƈts the ſcarlet to be left twenty-four hours in a cold ſolution of ammoniacal muriat and pot-aſh.

To dye crimſon at once, a ſolution of two ounces and a half of alum, and an ounce and a half of tartar, to every pound of cloth, is uſed for the boiling: and the cloth is afterwards dyed with an ounce of cochineal. Solution of tin is commonly added, but in leſs proportion than for ſcarlet. The proceſſes employed vary greatly, according as the ſhade required is deeper or lighter, or more or leſs diſtant

from

from ſcarlet. Some uſe common ſalt for the boiling.

Archil and pot-aſh are frequently uſed for ſaddening crimſons, and giving them more bloom: but the bloom thus imparted ſoon vaniſhes.

The boiling for crimſon is ſometimes made after a ſcarlet reddening, by adding tartar and alum: and it is aſſerted, that the ſoupe au vin has more bloom, if both its boiling and reddening be made after ſcarlet, than when it is dyed in a freſh bath. For theſe colours the cochinilla ſylveſtris may be uſed inſtead of the fine; but, as it contains leſs colouring matter, its quantity muſt be greater.

The reddening which has been uſed for crimſon may be employed for purples, and other compound colours, which will be treated of hereafter.

Scarlets and crimſons in half-grain are made by ſubſtituting madder for half the quantity of the cochineal, giving the ſame boiling as for ſcarlet in grain, and following in other reſpects the proceſſes for reddening the ſcarlet or crimſon. Other proportions of madder may be uſed inſtead of half, according to the effect we would obtain. Common madder red, alſo ac-

quires a greater luſtre, if its boiling be made after a reddening for ſcarlet.

In ſilk the grain crimſon, produced by cochineal, is diſtinguiſhed from falſe crimſon, which is obtained by means of braſil wood.

Silk deſigned to be dyed crimſon with cochineal, ought not to be boiled with more than twenty pounds of ſoap to a hundred of ſilk, as the ſlight yellow caſt which ſilk has when only ſo far ſcoured is favourable to the colour.

When the ſilk is well cleanſed from the ſoap at the river, it is to be put into an alum liquor of the full ſtrength. In this, it is commonly left from the evening till the next morning; after which it is to be waſhed, and twice beetled at the river.

To prepare the bath, a long boiler is half or two-thirds filled with water; and when the water boils, white galls powdered are thrown in, from half an ounce to two ounces for every pound of ſilk. After boiling a few moments, from two to three ounces of cochineal, powdered and ſifted, for every pound of ſilk, according to the ſhade required, are put in, adding afterwards an ounce of tartar to every pound of cochineal, and as ſoon as the tartar is diſſolved, an ounce of ſolution of tin to every

ounce

ounce of tartar. This ſolution ought to contain more tin than that uſed for ſcarlet, otherwiſe the colour would be too bright. Macquer directs it to be made with one pound of nitric acid, two ounces of ammoniacal muriat, ſix ounces of fine grain tin, and twelve ounces of water.

When theſe ingredients are mixed, the boiler is to be filled up with cold water. The proportion of the bath is about eight or ten quarts of water to every pound of ſilk. In this the ſilk is immediately dipped, turning it on the ſkein ſticks till it appears to be of an uniform colour. The fire is then increaſed, and the bath made to boil for two hours, turning the ſilk from time to time. After this the fire is put out, and the ſilk put into the bath, where it is kept a few hours longer. The ſilk is then waſhed at the river, giving it two beetlings, wrung, and dried.

If crimſons are to be ſaddened, they muſt be paſſed, after having been waſhed, through a ſolution of ſulphat of iron, more or leſs ſtrong according to the ſhade required. If it ſhould have a yellow tinge, a greater or leſs proportion of decoction of fuſtic is to be added to the ſolution.

White galls are chosen, because black would dull the colour of the crimson; and even too large a quantity of the white will produce the same effect. Macquer says, that the galls serve only to increase the weight of the silk: yet their general effect is to render colours more permanent, and they are at least indispensable for crimsons intended to be saddened.

Vinegar is used to distinguish grain crimsons from false: but this will not detect colours obtained from brasil wool, if they be fixed by means of solution of tin; as then, they stand the proof with vinegar as well as those made with cochineal.

In Macquer's treatise on dyeing silk, we find descriptions of the mode of dyeing it crimson at Damascus and Diarbekir, communicated by Granger, and of the process followed at Genoa.

It has been seen, that a very small quantity of solution of tin is put into the bath for dyeing silk crimson. If the same process as that for dyeing wool scarlet, were employed, the silk would lose its bloom, and acquire only a faint colour. Macquer and Scheffer, however, have both published processes which differ from it only in a few circumstances, for dyeing

dyeing ſilk roſe and poppy colours by means of ſolution of tin, uſed cold, that it might not act too violently on the ſilk.

In the proceſs which Macquer publiſhed in 1768, the ſolution of tin is prepared from three pounds of tin, four pounds of nitric acid, and two pounds of muriatic. The acids being mixed, the tin is to be thrown in, a little at a time. When the ſolution is finiſhed, ſix pounds of ſilk, that has already had an annotta bath, are to be put into it, and left there half an hour. The ſilk is then to be wrung, and waſhed as long as it makes the water foul. To dye it, four ounces of cochineal, and a quarter of an ounce of tartar, are taken for every pound: when the water into which theſe are put boils, cold water is added, till the hand can be ſuffered in it: the ſilk is then put in, the fire is increaſed, and the ſilk, after having been boiled a minute, is taken out and waſhed. By this proceſs the ſilk acquires an increaſe of one-fourth of its weight. Its colour will ſtand ſoap, and is much more permanent than that given it by carthamus.

In 1751 Scheffer publiſhed in the ſwediſh language a deſcription of the following proceſs. One part of tin is diſſolved in a mixture of four parts of nitric acid and one of common

ſalt,

falt. This folution being diluted with twice its quantity of water, the filk is left to fteep in it for twenty-four hours; after which it is taken out, and wafhed in clear water till it no longer renders it milky. This filk is dyed by boiling a quarter of an hour with five-fixths of its weight of cochineal in a fmall quantity of water. The liquor remaining contains a confiderable portion of colouring matter, which may ferve for dyeing filk a lighter fhade, or for dyeing crimfon in the common way. It may alfo be ufed for dyeing wool.

Scheffer defcribes fome variations in his procefs, for obtaining different fhades. I fhall relate the principal. If the filk be wrung out of the folution of tin, left all night in a cold folution of alum, an ounce to a quart of water, wrung and dried, then wafhed, and afterwards boiled with cochineal, it will take only a pale poppy colour. If the filk be fteeped twelve hours in the folution of tin diluted with eight parts of water, then left all night in the folution of alum, wafhed, dried, and paffed through two baths of cochineal as before, adding to the fecond bath a little fulphuric acid, it will be of a fine poppy red.

The chief difference in the two proceffes of Macquer and Scheffer confifts in the yellow

ground

ground which the former gives the ſilk. Scheffer uſes a greater proportion of cochineal in the dye bath.

In the experiments I have made on this ſubject, the ſolution of tin which ſucceeded beſt was the ſame as I have directed for dyeing ſcarlet: this procured me a fine cherry colour, ſufficiently bright. Solutions containing a greater proportion of tin gave me deeper ſhades: and the ſolution of the murio-ammoniacal ſalt of tin produced a dull deep crimſon. Though I have varied my experiments in ſeveral ways, I have never been able to obtain a ſhade comparable to ſcarlet: and I have been informed by thoſe who aſſiſted at Macquer's trials at the Gobelins, that the ſilk dyed by his proceſs never reached that colour. Scarlet, however, is ſo much in requeſt, as to have excited artiſts to repeated attempts for obtaining it. Thoſe who appear to have approached neareſt to the deſired end begin with dyeing the ſilk crimſon; this dye they cover over with that of carthamus, by the proceſs hereafter to be deſcribed; and laſtly, they give it a yellow dye without heat. By theſe means a fine colour is obtained, but the action of the air deſtroys the dye of the carthamus, and ſoon darkens the colour.

Cochineal is little uſed for dyeing cotton and linen, becauſe a fine and permanent red may be given them by means of madder. Scheffer, however, deſcribes a proceſs, which might be employed. The linen and cotton is to be ſteeped twenty-four hours in a cold ſolution of tin: it is then wrung, waſhed, and boiled a quarter of an hour with four-ſixths of its weight of cochineal. The cotton takes a light red. Theſe colours ſtand the ſun, but not ſoap.

The difference of the proceſſes to which recourſe muſt be had for giving cotton and ſilk a ſcarlet colour, appears to me to be owing to the ſlight diſpoſition theſe ſubſtances have for combining with the colouring matter of cochineal, or the compound of that colour and tin. Hence it follows, that this compound ſeparates, unites in too large maſſes, and precipitates before its union with the ſtuff can take place. This inconvenience is prevented by firſt impregnating the ſtuff with ſolution of tin; becauſe the oxyd of tin being combined with it, the colouring matter of the cochineal comes to fix in it, and then the compound can no longer precipitate.

Hence it appears, that this mode of operating ought to be tried, whenever we have reaſon to fear, that from the too feeble attraction of

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the ſtuff, the compound which is to colour it, will precipitate before it can fix in it.

CHAP. VI.

Of Kermes.

KERMES *(coccus ilicis, Lin.)* is an inſect found in many parts of Aſia and the ſouth of Europe. It was known to the ancients by the name of *coccum ſcarlatinum, coccus baptricus, coccus infectorius, granum tinctorium.* That which came from Galatia and Armenia was preferred; but at preſent it is gathered chiefly in Languedoc, Spain, and Portugal.

The kermes lives on a ſmall kind of oak *(quercus coccifera, Lin.)* The females grow big, and at length remain motionleſs; when they are nearly the ſize and ſhape of a pea, and of a reddiſh brown colour. On account of their figure they were a long time taken for the ſeeds of the tree on which they live; whence

whence they were called *grains of kermes.* They alſo bore the name of vermillion.

The firſt who has ſpoken of them with any accuracy is Peter de Quiqueran, biſhop of Senez, who mentions them in his book, *De Laudibus Provinciæ*, 1550.

The hiſtory of this inſect may be ſeen in a memoir of Niſſole, *Acad. des Sciences*, 1714, and more particularly in Reaumur's *Mémoires pour ſervir à l'Hiſtoire des Inſectes*, tom. iv.

Kermes has been ſuppoſed to have derived its name from an Arabic word, ſignifying a little worm, *vermiculus*; whence the name of *vermillion*, which alſo has been given it. Aſtruc derives the name from two Celtic words, one of which ſignifies *an oak*, the other *an acorn* [a].

The kermes fixes itſelf to the bark of the ſhrub on which it is found, by means of a cottonny down which it is capable of furniſhing. Mr. Chaptal has obſerved, that this down, like that of all the inſects of this kind, has many characteriſtics of the caoutchouc: it is inſoluble in alcohol, melts at the heat of boiling water, and burns with a flame on the

[a] Mémoire pour ſervir a l'hiſtoire naturelle du Languedoc.

coals.

coals. That learned chemift has given me the following defcription of the mode of gathering it in Languedoc.

" About the middle of May they begin to " gather kermes, which is then arrived at its " ordinary fize, and in colour and fhape re- " fembles a fmall floe (prunelle). This harveft " generally continues to the middle of June, " and fometimes longer, if the great heats be " retarded, or no violent rains fall; for one " heavy ftorm of rain is fufficient to put an " end to the gathering for that year.

" In this occupation women are generally " employed. They fet out early in the morn- " ing, with a lantern and a glazed earthen " pot, to pick off the kermes from the branches " with their fingers before day. This time " is the moft favourable, 1ft. Becaufe the " leaves, which are prickly, are then lefs " troublefome, being foftened by the morning " dew: 2dly. Becaufe the kermes weighs " more, whether becaufe it is not dried by " the fun, or becaufe it has parted with fewer " of its young, which are hatched by the " warmth. Some, however, are bold enough " to gather it in the day-time: but this is " rarely done.

" A fingle

" A ſingle perſon may gather one or two " pounds a day.

" At the beginning of the harveſt, the kermes " weighs more, but fetches a leſs price than at " the end, when it is drier and lighter.

" The price of freſh kermes varies alſo " according to the demand for it, and its " ſcarcity. It commonly ſells for fifteen or " twenty ſous a pound, at the beginning of " the gathering, and for thirty or forty to- " wards the end.

" The buyers are obliged as ſoon as poſſible " to ſtop the progreſs of the eggs, in order " to prevent the young contained in the ſhell " from getting out. This ſhell is nothing but " the body of the mother, diſtended by the " growth of the eggs. The female has no " wings: it ſettles itſelf on a leaf, where it " fixes: the male comes to fecundate it: and " it afterwards increaſes in ſize merely from " the growth of the eggs. To kill the young " contained in theſe, the kermes is ſteeped " ten or twelve hours in vinegar, or expoſed " to the ſteam of vinegar, which requires leſs " time, as half an hour is ſufficient. It is " afterwards dried on linen cloths. This " operation gives it a colour like that of red " wine."

If

If the living inſect be bruiſed, it gives out a red colour. Its ſmell is ſomewhat pleaſant: its taſte a little bitter, rough, and pungent. When dry it imparts this ſmell and taſte to water, and alſo to alcohol, to both of which it gives a deep red colour. This colour is retained by the extracts made from theſe infuſions.

To dye ſpun worſted with kermes, it is firſt boiled half an hour in water with bran; then two hours, in a freſh bath, with one fifth of Roman alum, and one tenth of tartar, to which *ſour water* is commonly added; after which it is taken out, tied up in a linen bag, and carried to a cool place, where it is left ſome days. To obtain a full colour, as much kermes as equals three fourths, or even the whole of the weight of the wool, is put into a warm bath, and the wool is put in at the firſt boiling. As cloth is more denſe than wool, either ſpun or in the fleece, it requires one fourth leſs of the ſalts in the boiling, and of kermes in the bath. Leſs proportions of kermes will produce lighter and paler colours. If we want a ſucceſſion of ſhades, we muſt, as uſual, begin with the deepeſt.

Hellot directs a ſmall handful of cot or refuſe wool to be thrown into the boiler in

which the kermes is, and to let it boil a moment, before the wool to be dyed is put in. This will abſorb a kind of black dregs, and the wool afterwards dipped, will take a better colour. Before the wool that is juſt dyed is taken to the river, it may be dipped in a bath of water a little warm, in which a ſmall quantity of ſoap has been diſſolved. In this way the colour will acquire more brightneſs, though it will be rendered a little roſy, that is, will have a crimſon caſt.

By uſing kermes and tartar, without alum, and with as much ſolution of tin as is required for a ſcarlet with cochineal, Hellot obtained a very lively cinnamon colour in a ſingle bath. Cloth ſteeped in a ſolution of ſulphat of potaſh, took with kermes a pretty fine and permanent agate gray: in a ſolution of ſulphat of ſoda, a dirty gray of little durability: in a ſolution of ſulphat of iron and tartar, a fine gray: in a ſolution of tartar and ſulphat of copper, an orange colour: and the ſame with nitrat of copper. Solution of biſmuth added drop by drop to a kermes bath, produced a violet. All acids convert it to a cinnamon colour, which inclines more or leſs to red, according as the acids are weak, and their

quantity ſmall. Alkalis render its colour dull and roſy.

The colour that kermes imparts to wool has much leſs bloom than the ſcarlet made with cochineal, whence the latter has generally been preferred, ſince the art of heightening its colour by means of ſolution of tin has been known. The former however, is more permanent; and ſpots of greaſe may be diſcharged from it without injury. It is a blood red, and is ſtill to be ſeen unchanged in old tapeſtry. The ſcarlet made by kermes was called *ſcarlet in grain,* becauſe that inſect was ſuppoſed to be a grain: it was alſo called venetian ſcarlet, becauſe its chief manufactory was in the city of Venice.

Solution of tin has been tried with kermes as well as with cochineal; and Scheffer deſcribes ſeveral proceſſes for dyeing in this way: but the colour always inclines to yellow or cinnamon, becauſe the compound formed of its colouring matter and the oxyd of tin, retains a yellow hue, from the action of the acid, as does the colouring matter of madder.

The permanency of the colour of kermes has frequently made it be regretted, that our dyers have relinquiſhed the uſe of it, as they

at prefent employ very little. Some mix a fmall quantity with cochineal; and this has been obferved to give a greater body (plus de fond) to the colour, but it diminifhes its bloom. The greater part of the kermes we have comes from the Levant.

No one has yet been able to give filk any thing more than a dull reddifh colour with kermes.

Scarlet, for which half kermes and half madder is ufed, is called fcarlet in *half grain*. This mixture gives a very permanent dye; but it is not lively, and inclines a little to the blood-colour. The turbans manufactured at Orleans for the Levant, are faid to be dyed in this manner: though probably a little brafil-wood is added.

The coccus polonicus is a fmall round infect, found adhering to the roots of a fpecies of polygonum *(fclerantus perennis)*. It is gathered in fome parts of Poland, towards the end of June. Its properties appear to refemble thofe of kermes; but no ufe is made of it in Europe. It is fold to the Turkifh and Armenian merchants; and is ufed in Turkey, for dyeing wool, filk, and horfe-hair: the women alfo ufe it to colour their nails.

There

There are many other infects which alfo afford a red colour; and fome of them have been employed for that purpofe: but from the advantages offered by cochineal, they have fallen into neglect or difufe.

CHAP. VII.

Of Lac, or Gum-Lac.

LAC is a fubftance of a colour more or lefs red; it is brought to us from the Eaft-Indies in different forms. This fubftance is analogous to that of the combs of bees, and conftructed by a fpecies of winged ants, generally on the fmall branches of the *croton lacciferum*.

Geoffroy, who has publifhed fome interefting obfervations on this fubject [a], confiders it as a true wax, indebted for its colour to the embryos of the infects, which have formed

[a] Mém. de l'acad. 1714.

alveoli in it which are nearly of a round ſhape; ſo that the name of a gum is highly improper.

Many ſorts of lac are diſtinguiſhed; the principal of which are: 1ſt. Stick-lac. This is what the ants conſtruct around the little branches or twigs which the inhabitants take care to plant as ſupports to their work. It is the moſt rich in colour: though there is ſome of it at Madagaſcar nearly colourleſs. 2d. Seed-lac. This is leſs coloured than the preceding ſort. 3d. Shell-lac. This is brought to us in thin plates, differing in ſize and in tranſparency. It has generally a dirty colour, and is mixed with wood and earth. There is ſome reaſon to believe, that its colouring matter has already been extracted by the Indians.

The ſecond and third ſorts are uſed for making ſealing wax, colouring it for red wax with minium, for black with lamp-black, for aventurine or gold-colour with orpiment, &c. Geoffroy ſays, that lac, ſeparated from the little bodies it contains, yielded him, on diſtillation, the ſame products as wax; and the ſmall bodies, which are reducible to a fine red powder, the products of animal ſubſtances. The colouring matter, which ariſes from theſe little

little bodies, ſuppoſed by him to be chryſalides, is ſoluble both in water and alcohol, and gives them a fine red colour.

For dyeing, ſtick-lac of the deepeſt colour ſhould be choſen. It is to be ſeparated from the ſticks and powdered.

The colour obtained by means of lac has not the bloom of ſcarlet made with cochineal, but has the advantage of being more permanent. It may be employed to good purpoſe, by mixing a certain quantity with cochineal, when, if it be not in too large proportion, the ſcarlet will be rendered more permanent, without loſing any thing of its beauty.

To ſeparate the part ſoluble in water, and calculate its proportion to the wax or reſin, Hellot uſed to extract it by means of water and mucilage of comfrey, to precipitate the colouring matter with alum, and to collect and dry this precipitate, the weight of which was only one fifth of the lac. This precipitate is a compound of the colouring matter and alumine or the baſe of alum: and this he uſed for dyeing.

Lac may be uſed in a more ſimple manner. Nothing more is neceſſary than to boil the cochineal and ſolution of tin for a proper

length of time; after which the bath is to be cooled, and the lac put in, in powder. It requires a very moderate heat, otherwise it will dye very unequally; and also a greater proportion of solution of tin than cochineal. The cloth ought to be washed very hot at coming out of the boiler, because the resinous particles fixed in it are difficult to separate when cold. Lac may be used with success for soupe au vin colour, putting it into the boiling, in which there must be no alum, as that would precipitate its colouring matter too quickly. Cochineal is to be used in the reddening, and it is to be saddened in the usual manner.

According to Hellot, fixed alkali or lime-water changes the bright red produced by lac to the colour of wine lees, and the muriat of ammoniac gives it a cinnamon colour, or light marrone, according as there is more or less of that salt.

Geoffroy conjectures, that lac is used for dyeing the red morocco of the Levant, after it has undergone a suitable preparation. It appears, in fact, that lac is used with cochineal for this purpose at Diarbekir, and that at Nicosia they use kermes. Mr. Quemiset asserts,

ſerts, that kermes, lac, or cochineal, may be uſed indifferently [b].

What appears to give lac the ſuperiority over kermes, is, that it is able to bear the action of ſolution of tin, and experiences the good effects of it, without its colour being changed to yellow; and it even requires, as has been ſeen, a greater proportion of it than cochineal.

CHAP. VIII.

Of Archil.

THE archil uſed in dyeing is in the form of a paſte, and of a red violet colour. Two ſorts are chiefly diſtinguiſhed; herb, or Canary archil; and ground (de terre) or Auvergne archil, which is alſo called pérelle. The firſt, which is moſt valued, is prepared from a ſpecies of lichen *(lichen roccella)* which

L'art d'apprêter & de teindre toutes ſortes de Peaux.

grows

grows at Cape-Verd, and the Canary islands, on the rocks near the sea: the second is made from a lichen *(lichen parellus)* that grows on the rocks of Auvergne.

Micheli, as quoted by Hellot, says, that the workmen who prepare archil at Florence, reduce the plant to a fine powder, which they pass through a sieve, and afterwards moisten slightly with stale urine: this mixture they stir once a day, adding each time a certain proportion of powdered soda, till it has acquired a dove colour: they then put it into a wooden cask, and add urine, or lime water, or solution of gypsum, sufficient to cover it; and keep it in this state. In the description given in Plictho, sal ammoniac, sal gem, and saltpetre, are added in the preparation: but Hellot is convinced from experience, that lime and urine are the only ingredients necessary; and that the mixture must be frequently stirred, adding at the same time fresh quantities of these. It is proper at the end of the process, to let the volatile alkali which has formed evaporate, that the archil may have the violet smell of that which is well prepared. To preserve it any length of time however, it must be kept moistened with urine.

Kalm

Kalm ſays, in an appendix to a memoir of Linnæus in the Stockholm tranſactions for 1745, that two lichens, which he deſcribes, are uſed in ſome parts of Sweden for dyeing red; and it is alſo ſaid, in the ſame tranſactions for 1744, that there is a ſpecies of lichen found in Sweden (*lichen foliaceus umbilicatus ſubtus lacunoſus*, Lin. Flor. Suec.) which, being prepared with urine, dyes wool and ſilk a fine and permanent red or violet.

There are perhaps many other ſpecies of moſs and lichen, which might be uſeful in dyeing, if they were prepared in the ſame manner as archil. Hellot gives the following method of diſcovering whether they poſſeſs this property, or not. A little of the plant is to be put into a glaſs veſſel, and moiſtened with ammoniac and an equal quantity of lime-water, adding a little muriat of ammoniac or ſal ammoniac: the phial is then to be corked. In three or four days, if the plant be of a nature to afford a red colour, the little liquor which can be poured off will be tinged of a crimſon red, as will alſo the plant itſelf. If the liquor or the plant, do not aſſume that colour, nothing is to be expected from it, and it would be uſeleſs to attempt its preparation in the large way. Lewis however ſays, that he

he has tried a great number of moſſes in this way, and that the greater part afforded him a yellow or reddiſh brown colour, whilſt a very few gave him a deep red liquor, that communicated only a yellowiſh red to cloth [a].

Prepared archil readily gives out its colour to water, volatile alkali, and alcohol. Its ſolution in the latter is uſed for making thermometers with ſpirits: and when theſe thermometers are thoroughly deprived of air, the liquor loſes its colour in a few years, as Nollet has obſerved [b]. The contact of air reſtores the colour; which is again deſtroyed in vacuo by time. The aqueous infuſion loſes its colour in a few days, if deprived of air: a ſingular phenomenon, which merits further inquiry.

The infuſion of archil is of a crimſon inclining to violet. Acids give it a red colour: but, as it contains ammoniac, by which its natural colour has been already modified, fixed alkalis produce little change in it, only rendering its colour ſomewhat deeper, and more inclined to violet. Alum forms with it a dark red precipitate: and the ſupernatant liquor retains

[a] The works of Caſpar Neumann.

[b] Mém. de l'acad. 1742.

a yellowiſh

a yellowiſh red colour. Solution of tin produces a reddiſh precipitate, which falls down very ſlowly; the ſupernatant liquor retains a ſlight red tinge. Metallic ſalts produce with it precipitates which exhibit nothing remarkable.

The aqueous ſolution of archil applied to cold marble, penetrates it, and imparts to it a fine violet colour, or blue inclining to purple, which reſiſts the action of the air much longer than colours communicated by archil to other ſubſtances. Dufay ſays, that he has ſeen marble ſtained with this colour unaltered at the end of two years.

To dye with archil, the quantity judged neceſſary, according to the quantity of wool or ſtuff to be dyed, and the ſhade to be given it, is mixed in a bath beginning to grow warm. The bath is then heated till it is ready to boil, and the wool or ſtuff is dipped in it, without any other preparation, keeping that in longeſt, which is to be of the deepeſt ſhade. A beautiful gridelin inclining to violet is thus obtained, but the colour has no permanency; ſo that archil is rarely uſed, except for modifying, heightening, or giving bloom to other colours. Hellot ſays, that having applied archil on wool boiled with alum and tartar, the

the colour did not ſtand the air any better than when the wool had undergone no preparation. But he obtained a much more permanent colour from the herb archil, by putting a little ſolution of tin into the bath. This changes the natural colour of the archil to one more or leſs approaching to ſcarlet, according to the quantity of the ſolution employed. This proceſs is to be conducted nearly in the ſame manner as that for dyeing ſcarlet, except that it requires only one bath.

According to Mr. Poerner, one pound of wet cloth, boiled for about an hour in a bath compoſed of ten ounces of archil and an ounce and a half of tartar, acquires a bluiſh red colour. If previouſly prepared with tartar and ſolution of tin, it aſſumes an amaranth colour: and if prepared with alum, a paler and leſs lively colour than the foregoing.

Archil is frequently uſed for deepening different ſhades, and giving them a bloom. It is thus uſed for violets, lilacs, mallow, and roſemary flower colours (mauve, fleur de romarin).

To obtain a deeper tint, alkali, and cremor calcis (lait de chaux) diffuſed in water, are ſometimes added to it as for deep ſoupe au-vin colours. The remainder of this liquor will

will give beautiful agate, rofemary flower, and other delicate colours, which cannot be procured equally fine by any other means. Alum cannot be employed inftead of this fubftance for deepening colours, as it does not afford the fame bloom, and tarnifhes the colour.

Herb archil is fuperior to that of Auvergne, as it communicates a greater bloom, and abounds more in colouring matter. It has the advantage too, of bearing to be boiled: and the latter cannot be mixed with alum, as it deftroys its colour. The herb archil however, has the inconvenience of dyeing unequally, at leaft if the cloth be not paffed through hot water the inftant it comes out of the dye.

Archil is never employed alone for dyeing filk, unlefs for lilacs: but filk is frequently dipped in an archil bath, either before or after dyeing in others, to modify various colours, and give them a bloom. Many inftances of this will be given in treating of compound colours: here I fhall mention only the manner of treating white filks with the archil bath. The fame procefs is employed, in a bath more or lefs charged with this fubftance, for filks already dyed.

A quantity

A quantity of archil proportionate to the colour required, is boiled in a proper veſſel. The clear liquor is then poured quite hot, leaving the dregs at the bottom of the boiler, into a trough of a convenient ſize, in which the ſilk, carefully cleanſed from ſoap, is to be turned with great care, till it has acquired the proper ſhade. The ſilk is then to be beetled once at the river.

Archil is a ſubſtance of great uſe in dyeing: but as it is rich in colour, and communicates a ſeducing bloom, dyers are frequently tempted to make an improper uſe of it, and to go beyond thoſe proportions which would add to the beauty of colours, without any great injury to their permanency. The colour, however, obtained from it by means of ſolution of tin, which is red, and approaches to ſcarlet, is leſs fugitive, than thoſe in which that ingredient is not employed. This ſolution appears to be the only thing capable of increaſing its durability. It may be employed not only in the dye-bath, but in the preparation of the ſilk, when by mixing archil with other colouring ſubſtances, bright colours ſufficiently permanent may be obtained.

CHAP.

CHAP. IX.

Of Carthamus.

CARTHAMUS, or baſtard ſaffron *(carthamus tinctorius)* of which the flower only is uſed in dyeing, is an annual plant, cultivated in Spain, Egypt, and the Levant. There are two varieties of it; one with larger leaves, the other with ſmaller. The latter is ſaid to be that of Egypt; where it makes a conſiderable article of trade.

Carthamus was formerly cultivated in Thuringia and Alſatia; but the preference given to that of the Levant has occaſioned its culture to be nearly abandoned in our climates. The celebrated Beckmann, who has publiſhed a very intereſting diſſertation on carthamus [a], has endeavoured to diſcover the difference between that produced with us, and that brought from the Levant: but previous to relating his obſervations, it will not be amiſs to give an account of the properties of this ſubſtance, ſuch as it is employed in dyeing.

[a] Comment. Societat. Gotting. tom. iv. 1774.

Carthamus contains two kinds of colouring matter; the one, yellow; the other, red. The first alone is soluble in water: its solution is always turbid: with reagents it exhibits the appearances commonly observed in yellow colouring matter: acids render it lighter, alkalis make it deeper, and more approaching to orange: both produce a small portion of a fawn-coloured precipitate, by means of which it becomes clearer. Alum forms with it a deep yellow precipitate in small quantity: solution of tin, and other metallic solutions, precipitates which have nothing remarkable.

Alcohol acquires but a slight tincture from the flowers, after all the yellow substance has been extracted by repeated washings. If these flowers be put into a solution of caustic alkali, they become yellow, and the liquor which is pressed out is of a deep yellow colour. On saturating the alkali with an acid, the liquor becomes turbid, reddish, and gradually deposits a very small quantity of a reddish yellow precipitate. With solutions of alum, zinc, and tin, a yellow precipitate is formed; and with solutions of iron and copper, a precipitate inclining to green. If instead of a solution of caustic alkali, a solution of carbonat of alkali be used, acids produce with it a more copious precipitate

precipitate of a redder hue: but the redneſs differs according to the acid employed. Alum alſo produces with the latter alkaline ſolution, a red precipitate, which is ſo light, that it generally ſwims on the ſurface of the liquor. This colouring matter is ſo delicate, and ſo eaſily changed, that if heat be employed to diſſolve it, the precipitates produced by acids will not have ſo fine a colour.

Mr. Beckmann has obſerved, that the carthamus of Thuringia contained much more of the yellow matter, than that of the Levant: that in other reſpects the red matter of the former was by no means inferior in beauty to that obtained from the latter: yet, that to produce equal effects, half as much more of it was required. He next examined, whether this difference depended on the climate, or only on the mode of preparation.

Haſſelquiſt relates, in his travels in Egypt, that when the flowers of carthamus are gathered, they are preſſed between two ſtones, to ſqueeze out the juice. After this they are waſhed ſeveral times with water, which in Egypt is naturally ſalt. When taken out of the water they are preſſed between the hands, and then ſpread on mats, placed on the flat roofs of their houſes; where they are covered in the day time, that

the ſun may not dry them too faſt, but left expoſed to the dew at night. They are occaſionally turned, and when ſufficiently dry, taken in, and kept for ſale under the name of *ſaffranon.*

If the carthamus of the Levant, ſuch as it is in commerce, be compared with that of Thuringia, the former will be found to be more pure, a little moiſt, and in compreſſed maſſes; the latter, drier and more elaſtic. Theſe differences depend on the preparation. Writers on agriculture, deceived by the erroneous name of *baſtard ſaffron* given to carthamus, have ſuppoſed, that it ſhould be treated like ſaffron. Hence they direct it to be gathered in a dry ſeaſon, and dried with care. Mr. Beckmann thinks on the contrary, that the mode adopted in Egypt ought to be imitated. He adviſes even to add a little ſalt to the water uſed in preparing it, to give it the quality it has naturally in Egypt.

The flower of carthamus has a fine colour of fire, but in drying it grows yellow. It ſhould not be gathered till it grows dry; and it is better, if it has been rained upon in that ſtate, though the contrary opinion is erroneouſly held. The want of rain may be ſupplied by watering the flowers morning and evening. When they

they are gathered, the feeds may ftill be left to ripen.

The intention of thefe directions is, to promote the feparation of the yellow matter, the abundance of which conftitutes the difference between the carthamus of our climates, and that of the Levant. Carthamus fhould be kept in a moift place, as its becoming too dry would be injurious.

There are many reafons to induce us to enrich our agriculture with this production. The feeds of carthamus are very good food for wild fowl, and particularly for parrots, whence they have received the name of grain de perroquet. An ufeful oil might be expreffed from them, and the refidue given to cattle. The dry leaves and ftalks would ferve as fodder for fheep and goats in the winter; and thofe ftalks which are too large might be ufed as fuel, after they had ftripped them. Mr. Beckmann has found the carthamus ripen well at Gottingen, where the foil is fandy. The ground fhould be moderately dunged; and the plant neither tranfplanted nor watered.

No ufe is made of the yellow fubftance of carthamus: but to extract that part, it is put into a bag and trodden in water, till no more colour can be preffed out. The flowers, which

were yellow, become reddifh in this operation, and lofe nearly half their weight: it is in this ftate they are ufed.

The yellow fubftance might however be employed: and Mr. Poerner has made many experiments on the fubject [b]. The principal refults of his experiments were, that wool, without any preparation, takes from it a yellow colour, which is not permanent; but that which it takes after having been prepared with alum and tartar, though not very lafting, is better. Mr. Beckmann afferts, that cloth prepared with tartar, or with tartar and alum, acquires from it a good yellow colour; and that carthamus contains more yellow colouring matter than an equal weight of fuftic itfelf.

To extract the red part of carthamus, and afterwards apply it on the ftuff, recourfe is had to the property alkalis poffefs of diffolving it, and it is precipitated by means of an acid. It has been found, that lemon-juice produces the fineft colour. Mr. Beckmann fays, that next to this, the fulphuric acid produces the beft effect, provided a proper quantity only be ufed: too much of it would alter and deftroy the co-

[b] Chemifche Verfuche und Bemerkungen zum Nutzen der Farbekunft; dritter Theil.

lour.

lour. According to Scheffer, the juice of the berries of the ſervice tree *(ſorbus aucupatorius)* may be ſubſtituted for lemon-juice. It is thus prepared. The berries are bruiſed in a mortar with a wooden peſtle, and the expreſſed juice is left to ferment: it is then bottled, and the clear part, which is moſt acid, becomes fitter for uſe the longer it is kept. This operation requires ſome months, and ſhould be undertaken only in ſummer.

It has been ſeen, that the proceſs conſiſts in extracting the red colouring matter by means of an alkali, and precipitating it with an acid. From this precipitate is procured the *rouge* uſed by ladies. To make it, the ſolution of carthamus is prepared with cryſtals of ſoda, and precipitated by lemon-juice, which has ſtood ſome days to ſettle. It has been remarked, that lemons beginning to decay were fitter for this purpoſe than thoſe leſs ripe, the juice of which retains much mucilage. The precipitate of carthamus is dried on plates of delft with a gentle heat: from theſe it is ſeparated, and ground very accurately with talc, previouſly reduced to a very ſubtile powder by means of the leaves of ſhave-graſs, and paſſed ſucceſſively through ſieves of different degrees of fineneſs. The fineneſs of the talc, and its

proportion to the precipitate of carthamus, make the difference between the cheaper and dearer rouges.

Wool may be dyed red by means of carthamus, as Mr. Beckmann has experienced; but this red ſoon changes towards an orange: and as the fineſt and moſt various reds may be obtained from cochineal, which are at the ſame time much more permanent than thoſe of carthamus, the uſe of the latter for wool is relinquiſhed.

Carthamus is uſed for dyeing ſilk poppy colour, a bright orange red (nacarat) cherry, roſe, and fleſh colour. The proceſſes differ according to the intenſity of the colour to be given, and the degree in which it approaches that of fire: but the carthamus bath, which varies in the mode of uſing, is prepared as follows:

After having extracted the yellow matter of the carthamus, and opened the cakes, it is put into a deal trough, where it is ſprinkled at different times with *cendres gravelées*, or ſoda, the latter of which is beſt, well powdered and ſifted, in the proportion of ſix pounds to a hundred; mixing it well as the alkali is put in. This operation is called ameſtrer. The carthamus thus mixed with the alkali, is put into a ſmall

trough with a grated bottom, firſt lining it with a cloſely woven cloth. When this trough is nearly half filled, it is placed upon the large one, and cold water is poured on it till the lower trough is full. The carthamus is then ſet over another trough, till the water comes from it almoſt colourleſs. A little more alkali is then added, and freſh water is poured on. Theſe operations are repeated, till the carthamus is exhauſted, and become yellow.

The ſilk being diſtributed on the rods in hanks, lemon-juice, which comes from Provence in caſks, is poured into the bath, till it is of a fine cherry colour. This is called *turning* (virer) the bath. Having ſtirred the bath well, the ſilk is dipped in, and turned on the ſkein ſticks as long as it appears to get any colour. For poppy colour, it is taken out, wrung, drained on the pegs, and paſſed through a new bath, where it is treated as in the former. It is then dried, and paſſed through freſh baths, waſhing and drying it after every operation, till it has obtained the depth of colour required. When it is at the proper point, it is brightened, by turning it ſeven or eight times in a bath of hot water, to every bucket of which about a gallon of lemon-juice is to be added.

When ſilk is to be dyed poppy or fire colour, it muſt be firſt ſcoured as for white; and muſt then have a ſlight annotta ground, in the manner that will be mentioned when treating of that ſubſtance. This ſilk ought not to be alumed.

Bright orange reds and deep cherry colours are treated exactly in the ſame way as poppy colour, except that they have not the annotta ground, and that they may be dipped in the baths that have been already uſed for poppy colour, which will exhauſt them. Freſh baths are never made for theſe colours, unleſs the dyer have no occaſion for a poppy.

The lighter cherry colours, roſe colours of every ſhade, and fleſh colours, are made from baths of the ſecond and third runnings of the carthamus, which are weaker than the firſt. In theſe the deepeſt ſhades are firſt dipped.

The lighteſt of all theſe ſhades, which is a very pale fleſh colour, requires a little ſoap to be put into the bath: this ſoftens the colour, and prevents it from taking too quickly or unevenly. The ſilk is then waſhed, and brightened a little in the bath which has been uſed for brightening the deeper colours.

All theſe baths are uſed as ſoon as they are made, and as quickly as poſſible, as by keeping, they loſe much of their colour, which would

 even

even be entirely loft after a time. They are alfo ufed cold, becaufe the red feculæ lofe their colour on being expofed to heat. The reader muft have obferved, that in the experiments I have defcribed, cauftic alkalis attack the delicate colour of carthamus, and turn it yellow: on this account cryftals of foda fhould be preferred to any other alkali. At leaft we fhould choofe one that contains moft carbonic acid, as falt of tartar.

To leffen the expence of carthamus, it is ufual, for deep fhades, to mix with the firft and fecond bath about a fifth of the bath of archil.

When raw filk is to be dyed, that which is very white fhould be chofen, and treated as boiled filk, with this difference only, that the poppy colours, bright orange reds, and cherry colours, are paffed through baths that have been ufed for the fame colours for fcoured filk, becaufe the raw filk in general takes colours more readily.

Poppy colour prepared in an acid liquor refifts the action of vinegar, but it foon changes and fades in the air. Scheffer fays, that when he ufed the juice of fervices inftead of lemon-juice, the colour ftood fomewhat longer.

Mr. Beckmann has made ſome experiments on applying the red colour of carthamus to cotton [e]. Having macerated cotton two hours in melted lard, he waſhed it well, and dyed it in the common way with carthamus deprived of its yellow matter. This cotton took a deeper colour than ſome which had undergone no preparation. Soap ſucceeded equally well; and olive oil ſtill better. Mr. Beckmann then dipped his cotton in oil repeatedly, drying it each time. After the laſt drying he waſhed and dried it; and then paſſed it through the yellow bath of carthamus, to which he added galls and alum. Finally, he dyed it with the alkaline ſolution of carthamus and lemon-juice. By theſe means he obtained a fine full red. Cotton treated in the ſame manner, without having been impregnated with oil, took a colour of the ſame kind, but leſs full, and leſs capable of ſtanding the action of the air. From theſe experiments, he thinks, that cotton to be dyed with carthamus ſhould receive a preparation ſimilar to that given it for the Adrianople red.

To dye cotton poppy colour, Mr. Wilſon directs the carthamus, thoroughly freed from the

[e] Exper. Lina xylina tingendi Flor. Carth. tinct. Comment. Soc. Reg. Gotting. vol. iii. 1780.

yellow

yellow colouring matter, to be put into a veſſel, at the bottom of which is a hair ſieve, and to pour on it a ſolution of pearl-aſhes, mixing them well, and leaving them to ſtand all night. The next morning the liquor is to be drawn off by a cock at the bottom of the veſſel, and the cotton to be dyed is to be put into it, and turned by means of a winch. In the mean time a ſolution of tartar is prepared, and left to ſettle, and whilſt it is yet hot, it is poured into the carthamus bath, till the liquor is rendered a little ſour. The cotton muſt continue to be turned in this, till it has acquired the proper ſhade. It is then waſhed lightly, and dried in a ſtove. In this way it obtains a fine colour.

To give cotton a ſcarlet, it muſt firſt be dyed yellow, in the manner directed under the article annotta, and whilſt yet wet, muſt be dyed with carthamus, in the manner juſt deſcribed. It thus acquires a fine ſcarlet; but it is not permanent, and will not ſtand waſhing.

CHAP.

CHAP. X.

Of Brasil-Wood.

THIS wood, which is of extensive use in dyeing, derives its name from that part of America from which it was first imported. It bears also the names of Fernambucca, wood of St. Martha, of Japan, and of Sapan, according to the place where it was produced. At present it is cultivated in the Isle of France, where it is naturalized. That of the Antilles, called *brasiletto*, is least esteemed.

Linnæus describes the tree that furnishes brasil-wood by the name of *cæsalpinia crista*: that which gives the japan or sapan-wood, distinguished into large and small sapan-wood, by the name of *cæsalpinia sappan*: and that from which we have the *brasiletto* he calls *cæsalpinia vesicaria*.

This tree grows generally in dry places, and amidst rocks. Its trunk is large, crooked, and knotty. The flowers of the *cæsalpinia sappan* and *cæsalpinia vesicaria* have ten stamina; those of the true brasil-wood, only five.

That

That which comes from Fernambucca is moſt valued.

Braſil-wood is very hard, and ſuſceptible of a fine poliſh. It ſinks in water. It is pale when cut, but reddens on expoſure to the air; having different ſhades of red and orange colour. Its goodneſs is diſtinguiſhed chiefly by its weight. When chewed, it has a ſweetiſh taſte. It may be eaſily diſtinguiſhed from red ſanders, becauſe the latter does not give out its colour to water.

Boiling water takes the whole of the colouring matter from braſil-wood, and becomes of a fine red, if the boiling be continued long enough. From the reſiduum, which appears black, much colouring matter may ſtill be extracted by means of alkalis. The ſolution in ſpirit of wine, and that in volatile alkali, are deeper than the preceding. According to Dufay, a tincture of braſil-wood in alcohol will give hot marble a red colour, which changes to a violet. If the marble thus ſtained be covered with wax, and the heat increaſed, the colour will paſs through the different ſhades of brown, till it arrives at a chocolate.

Freſh decoction of braſil-wood yields, by the addition of ſulphuric acid, a ſmall quantity of a red

a red precipitate inclining to fawn-colour: the liquor remains yellow and tranſparent. Nitric acid renders the liquor yellow at firſt: but if more be added, the liquor acquires a deep orange colour, and becomes tranſparent, after having depoſited a precipitate nearly reſembling the former in colour, but more abundant. Muriatic acid acts on it like the ſulphuric. The oxalic acid produces a precipitate of an orange red, nearly as copious as the nitric acid does: the liquor remains tranſparent, and of the ſame colour as in the former trials. Diſtilled vinegar gives a very little precipitate of the ſame colour; the liquor remaining tranſparent, and a little more inclining to orange. Tartar furniſhes ſtill leſs precipitate, and leaves the liquor turbid, and redder than in the preceding inſtance. Fixed alkali reſtores the decoction to a crimſon, or deep violet, inclining to brown; and produces a ſcarcely perceptible precipitate of the ſame colour. Ammoniac gives a brighter purple, or violet, and a little precipitate of a fine purple. Alum occaſions a red precipitate, inclining to crimſon, copious, and ſubſiding ſlowly: the ſupernatant liquor retains a fine red colour, ſimilar to that of the freſh decoction: this liquor alſo affords a copious precipitate,

precipitate, on ſaturating the acid of the alum with an alkali. In this manner an inferior ſort of carmine is prepared, and alſo a liquid lake for miniature painting. Alum and tartar produce a little browniſh red precipitate; the liquor remaining very clear, and of an orange red. Sulphat of iron cauſes the tincture to aſſume a black colour, inclining to violet: the precipitate that falls down is abundant, and of the ſame colour, as is alſo the liquor that ſwims above it. Sulphat of copper likewiſe produces a great deal of precipitate, the colour of which is darker: the liquor remains tranſparent, and of a browniſh red. Sulphat of zinc gives a brown precipitate, ſmall in quantity, leaving the liquor tranſparent, and of the colour of pale beer. A ſolution of acetite of lead occaſions a copious precipitate, of a pretty fine deep red: the liquor is of an orange red and tranſparent. Solution of tin in the nitro-muriatic acid gives a very abundant precipitate of a fine roſe colour: the liquor remains tranſparent, and perfectly colourleſs. Finally, with corroſive ſublimate a light precipitate of a brown colour is obtained; the liquor remaining tranſparent, and of a fine yellow.

In the *Journal de Physique*, for February 1785, are some curious experiments on the action exerted by acids on the colour of brasil-wood. If, after having changed it yellow by means of tartar and acetous acid, the nitro-muriatic solution of tin be poured in, a very copious rose-coloured precipitate is immediately formed. If to the solution rendered yellow by an acid, a greater quantity of that acid, or an acid more powerful be added, the red colour will be restored. The sulphuric acid is best calculated to produce this effect. Some salts also restore the red colour of brasil-wood, which has been destroyed by the action of acids.

It has been remarked that the decoction of brasil-wood, called *juice* of brasil, is less proper for dyeing when fresh, than when it is old, or has even undergone fermentation. By keeping, it acquires a yellowish red colour. Hellot recommends the hardest water than can be had to be used for making this decoction: but it is necessary to observe, that such water deepens the colour by means of the earthy salts it contains. Having boiled the wood reduced into chips for three hours; the liquor is poured into a cask, fresh water is added to the brasil, it is boiled three hours longer, and this

this liquor is added to the former. When brasil-wood is used in a dye-bath or flat, it is proper to enclose it in a thin linen bag, as it is all colouring woods.

Wool dipped in the brasil-juice would acquire only a slight tint, that would soon fade: it is necessary therefore, that it should undergo certain preparations.

The wool is to be boiled in a solution of alum, to which a fourth of its weight, or even less, of tartar has been added. A greater proportion of tartar would render the colour yellow. The wool thus impregnated is to be kept at least a week in a cool place; after which it is dyed by boiling gently in the brasil-juice. The colouring matter which is first deposited does not yield so fine a colour: it is proper therefore, to dip the coarsest stuff in the bath first. In this manner a bright red is obtained, which stands the action of the air tolerably well.

If the red colour of brasil-juice be destroyed by means of any acid, it will give woollens a more or less deep dun colour, which is very permanent.

Mr. Poerner prepares the cloth with a boiling composed of solution of tin, alum, and a little tartar; and makes his bath with brasil-

wood, and a confiderable proportion of alum. In the refiduum of this bath he dyes a fecond piece, which has received a fimilar preparation. The firft piece takes a fine brick colour; the fecond, a colour that approaches fcarlet [a]. The fhades may be greatly varied by varying the proportions of the ingredients.

Colours obtained from brafil may thus be rendered tolerably permanent: yet they are not comparable in this refpect, to thofe obtained from cochineal, or madder. A bloom is fometimes given to colours produced from the latter fubftance, by paffing the cloth dyed with it through the brafil-juice: but this bloom foon vanifhes.

Mr. Guhliche gives a procefs, by which he pretends finer and more permanent colours are obtained, than by thofe in ufe. He directs pure vinegar, or aceto-citric acid [b], or aqua

[a] Inftruction fur l'art de la teinture.

[b] I give the appellation of *aceto-citric* acid to a liquor of which Mr. Guhliche makes great ufe in dyeing, under the name of vegetable acid fpirit, which he prepares in the following manner.

He takes any quantity of lemons, thofe of which the rind is rotten will do, removes the peel, and the fkin that adheres to it, and flices them into a veffel, which fhould not be made of wood. He then fprinkles them with a quantity

aqua regia, to be poured on braſil-wood, reduced to a powder, or very ſmall chips, till it is covered with the liquor, or even till the liquor is a certain height above it; the mixture to be well ſhaken, and then left to ſettle for twenty-four hours: after which it is to be decanted, filtered, and kept for uſe. On the reſiduum, a vegetable acid, or pure water, is to be poured, and having ſtood a day or two, filtered. This is to be repeated till all the colouring matter is extracted, when the wood will be found to be black. All theſe liquors are to be mixed together.

The ſtuff having been prepared with a ſlight galling of ſumach, or white galls, is ſlightly

quantity of good vinegar, which he thinks comes near that of the lemon-juice, ſqueezes out the liquor through a flannel, by means of a preſs, and filters the expreſſed liquor through paper. It may be uſed with ſucceſs in this ſtate; but it is apt to grow mouldy, and the acid is watery. In order that it may keep therefore, and not dilute the baths into which it is put, he directs it to be purified and concentrated as follows: The liquor is to be expoſed to the ſun, till a ſediment forms, and it grows clear. It is then to be filtered, and diſtilled in a ſand-bath. The receiver is to be changed when the liquor that drops becomes acid, and the diſtillation continued till oily ſtreaks are perceptible in the neck of the retort. The acid found in the receiver is to be kept for uſe.

alumed: being juſt rinſed, it is put quite wet into a bath prepared as follows:

Some of the acid ſolution of braſil-wood is diluted with a quantity of water proportionate to the quantity of the ſtuff, and the depth of the colour to be given it. When this is ſo hot that the hand will juſt bear it, ſolution of tin is poured in, till it is of a fire colour: it is then ſtirred and the ſtuff is put in. After this has remained in half an hour, it is taken out and waſhed. The remainder of the bath may be uſed for lighter ſhades: but thoſe ſtuffs only muſt be galled that are for deep ones.

Braſil-wood is uſed for dyeing ſilk what is called *falſe* crimſon, to diſtinguiſh it from that produced by means of cochineal, which is far more permanent.

The ſilk ſhould be boiled with ſoap, in the proportion of twenty pounds of the latter to a hundred of the former, and afterwards alumed. Leſs aluming is required for this than for grain crimſon. Having refreſhed it at the river, it is dipped in a bath, more or leſs charged with braſil-juice according to the ſhade to be given. If water containing no earthy ſalt be employed, the colour will be too red for crimſon; to remedy which, the ſilk may be paſſed through a ſlight alkaline ſolution, or a little alkali may

be

be added to the bath. Washing the silk in hard water, till it has acquired the proper hue, will answer the same purpose.

To make false crimsons deeper, or dark reds, juice of logwood is added to the brasil bath, after the silk has been impregnated with the latter. A little alkali may also be put in according to the shade to be obtained.

To imitate poppy or fire colour, the silk must have an annotta ground, even deeper than when it is to be dyed with carthamus: after which it is washed, alumed, and dyed with the brasil-juice, to which a little soap-suds is commonly added.

Solution of tin cannot be used for dyeing silk with the juice of brasil-wood, as with cochineal; and the reason in both is the same: the colouring particles would separate too quickly to be capable of fixing on the silk, which does not attract them so powerfully as wool. But as Bergman remarks, in his notes on Scheffer [c], the colours imparted by dye woods may be much improved by steeping the silk in a cold solution of tin. A strong decoction of brasil-wood, says he, gives yellow silk a scarlet colour, inferior indeed to

[c] Essai sur l'art de la teinture.

that given by cochineal, but finer and more permanent than if it be ſteeped in alum only, and as capable of ſtanding the proof by vinegar, as crimſon or poppy in grain. It is neceſſary, inſtead of uſing raw ſilk, to give a yellow ground to ſilk that has been ſcoured, or to mix ſome yellow ſubſtance with the braſil-juice. Of late many artiſts have turned their attention to this proceſs, and have produced various effects by applying it to different colouring ſubſtances, which of themſelves afford colours of little durability, either employing them alone, or mixed in various ways.

Mr. Guhliche however, deſcribes a proceſs in which he uſes ſolution of tin immediately, to give ſilk a fire colour. He directs the ſilk to be galled with a ſolution of galls in white wine, aſſerting, that an aſtringent ſolution thus made preſerves the brightneſs required in ſilks, much better than one prepared with water. With this ſolution he mixes water, till it has acquired a yellow colour; and impregnates the ſilk well with it, leaving it to ſteep in it cold for twelve hours. He then preſſes out the liquor ſtrongly, but without waſhing the ſilk, which he dries, and afterwards ſoaks for twelve hours in a ſolution of alum, containing

taining four ounces for every pound of ſilk. The ſilk, taken out of the alum water, is wrung, and put while wet into a bath, prepared as above directed, after adding to it an ounce of ſolution of tin. The remainder of the bath may be exhauſted for lighter ſhades. If the fire colour be required more approaching to orange, the ſilk is not to be galled, but to be alumed cold, with two ounces of alum to the pound of ſilk: after which it muſt be dyed orange colour with annotta, without boiling, and before it dries, dyed in the bath of braſil-wood above deſcribed. The author confeſſes, that theſe colours, particularly the latter, are not very permanent. For roſe colours he omits the galling, and for the aluming uſes only two ounces of alum. For light ſhades he recommends the ſolution of alum to be decanted from the ſediment that may have been depoſited, and prefers dyeing them cold, uſing a bath more rich of colour. The ſilk is to be taken out as ſoon as it has acquired the proper tint, and the bath may be exhauſted for other ſhades. He aſſures us, that with theſe precautions, fine colours of tolerable permanency may be obtained.

Mr. Poerner has made many experiments on methods that may be employed for dyeing cotton with brasil-wool by means of different mordants, as alum, solution of tin, sal ammoniac, pot-ash, &c. used either in the bath, or in the preparation of the cotton. He could not produce a colour however, that would stand washing with soap, though some would stand the action of the air, and washing with water, tolerably well. He recommends cotton thus dyed to be dried in the shade [d].

To Mr. Brown, a gentleman of great zeal for the improvement of the arts, I am indebted for the following process, used by some manufacturers for giving cotton a crimson colour.

A solution of tin is prepared in the proportions of nitric acid two pounds, muriatic acid one pound, tin eight ounces, water one pound. The liquids being mixed together, the tin is to be added by little and little.

For a piece of cotton velvet weighing fifteen or sixteen pounds, a bath is prepared, consisting of boiling water four parts, strong decoction of galls two parts. Having stirred the bath with the rake, the piece is put in, worked for half

[d] Versuche und Bemerkungen zum Nutzen der Farbekunst. Zweyter Theil.

an hour, and left to ſoak two hours, when it is taken out, and left to drain. Another bath being prepared with three buckets of boiling water, and one of decoction of braſil-wood, alſo boiling, is to be raked, and the piece worked in it an hour. This bath is to be thrown away, and the vat waſhed out, and then filled with a pure decoction of the wood, in which the piece is to be worked half an hour, and then raiſed on the winch. A bath of very clear river water, with a quart of ſolution of tin, being prepared and raked, the piece is to be worked in it a quarter of an hour. It is then raiſed on the winch, and ſet over the vat containing the bath of decoction of braſil-w od, one ſixteenth of which is to be taken out, and replaced by an equal quantity of boiling decoction. This being raked, the piece is worked in it half an hour, raiſed on the winch, and carried back to the vat containing the ſolution of tin. Theſe operations are performed alternately ſix or eight times, obſerving each time to take out a ſixteenth of the bath of braſil-wood, and replace it with an equal quantity of boiling decoction of the ſame wood, to rake the bath of compoſition each time, and to finiſh the dyeing with the latter. The piece is to be

be washed in the river, and dried in a dark place.

Methods have long been sought, for giving greater permanency to the fine and various colours obtained from brasil-wood at little expence. In using this substance we should call to mind some of its properties. The colouring matter of brasil-wood is easily affected and turned yellow by acids. It then becomes a permanent colour. But what distinguishes it from madder and kermes, and makes it resemble cochineal, is that it resumes its natural colour when precipitated in combination with alumine or oxyd of tin. These two combinations appear best calculated to render it durable. We should therefore seek the circumstances most proper to favour the formation of these combinations according to the nature of the stuff.

The astringent principle also appears to contribute to the permanency of the colour obtained from brasil-wood: but galling deepens it, and cannot be employed for light shades.

The colouring matter of brasil-wood is very easily affected by alkalis, which gives it a purple tint; and there are many processes in which alkalis, either fixed or volatile, are used

to form violets and purples: but the colours obtained by these means, easy to be varied according to the intention, are perishable, and have only a temporary brightness. Alkalis do not appear to injure colours obtained from madder; but they accelerate the fading of most others.

It appears, from what Mr. Wilson says, that in England woods for dyeing are ground in mills constructed for that purpose, and kept moistened with urine; or if the latter be not done, a little alkali is added when they are boiled.

The custom of reducing the woods to powder is advantageous, and ought to be adopted: but putrid urine and alkali, whilst they favour the extraction of the colouring matter, and heighten its colour, may frequently counteract the effect to be obtained, and must be injurious to the permanency of the colour.

CHAP.

CHAP. XI.

Of Logwood.

INDIA, Jamaica [a], or Campeachy wood, has received thoſe different names from the places where it grows moſt plentifully. It is very common at Jamaica, and on the eaſtern ſhore of the bay of Campeachy; and is found alſo at St. Croix, Martinico, and Granada.

The tree is called by Linnæus *hæmatoxylum campechianum.* It grows very high and large in a good ſoil: the bark is thin, ſmooth, and of a bright gray, or ſometimes yellowiſh: the trunk is ſtraight and prickly: the leaves ſomewhat reſemble thoſe of the bay-tree in appearance, and alſo in their aromatic qualities, whence the tree has been called *aromatic bay*, or *Indian bay*: its ſeeds have been improperly called *clove-ſeeds*, from their flavour, and in England are known by the name of *Jamaica pepper*, or *all-ſpice.*

[a] In England, the name of Jamaica wood is commonly applied to the better ſpecies of mahogany, the inferior kind being brought from Honduras. T.

Logwood

Logwood is ſo heavy as to ſink in water, hard, compact, of a fine grain, capable of being poliſhed, and ſcarcely ſuſceptible of decay. Its predominant colour is red, tinged with orange, yellow, and black.

For uſe, its *juice* is commonly extracted like that of braſil-wood. It yields its colour both to ſpirituous and watery menſtrua. Alcohol extracts it more readily and copiouſly than water. The colour of its dyes is a fine red, inclining a little to violet or purple, which is principally obſervable in its watery decoction. This, left to itſelf, becomes in time yellowiſh, and at length black. Acids turn it yellow: alkalis deepen its colour, and give it a purple or violet hue. Sulphuric, nitric, and muriatic acids, produce in it a ſmall quantity of a precipitate, which is ſome time in ſeparating, and its colour, with the ſulphuric acid, is a dark red; with the nitric, feuillemort; with the muriatic, a lighter red. The ſupernatant liquor is tranſparent, of a deep red colour with the ſulphuric and muriatic acids, and yellowiſh with the nitric. The oxalic acid forms a light marrone precipitate; the liquor remaining tranſparent, and of a yellowiſh red. The acetous acid acts nearly in the ſame manner, except that the colour of the precipitate is a little deeper. Tartar gives the

the ſame precipitate as vinegar, but the liquor remains turbid, and more inclined to yellow. Fixed alkali occaſions no precipitate, but changes the decoction to a deep violet, which afterwards becomes nearly brown. Alum produces a pretty copious precipitate, of a lightiſh violet colour; the liquor remaining violet, and nearly tranſparent. Alum and tartar occaſion a dark red precipitate in tolerable quantity; the liquor remaining tranſparent, and of a yellowiſh red. Sulphat of iron gives it inſtantly a blueiſh black colour, like that of ink; a pretty copious precipitate of the ſame colour forms, and the liquor remains turbid a long while; but if it be ſufficiently diluted, and eſpecially if there be a ſmall exceſs of the ſulphat, all the black matter is at length depoſited. Sulphat of copper produces a very copious precipitate, of a browner and leſs bright black than the preceding: the liquor remains tranſparent, and of a very deep browniſh or yellowiſh red. Acetite of lead inſtantly occaſions a black precipitate with a ſlight reddiſh tinge; the liquor remaining tranſparent, and of the colour of very pale beer. Finally, tin diſſolved in nitro-muriatic acid forms immediately a precipitate of a very fine violet or purple, almoſt prune

de

de monſieur: the ſupernatant liquor is very clear, and perfectly colourleſs.

Stuffs would take only a ſlight and fading colour from decoction of logwood, if they were not previouſly prepared with alum and tartar. A little alum is added alſo to the bath. By theſe means they acquire a pretty good violet.

A blue colour may be obtained from logwood, by mixing verdegris with the bath, and dipping the cloth till it has acquired the proper ſhade.

Theſe uſes of logwood have obtained it the names of violet wood and blue wood. Of theſe I ſhall ſpeak more largely, when I come to treat of compound colours.

The grand conſumption of logwood is for blacks, to which it gives a luſtre and velvety caſt (velouté), and for grays of certain ſhades. It is alſo of very extenſive uſe for different compound colours, which it would be difficult to obtain of equal beauty and variety, by means of drugs affording a more permanent dye.

Juice of logwood is frequently mixed with that of braſil, to render colours deeper; their proportion being varied according to the ſhade deſired.

Logwood is uſed for dyeing ſilk violet. For this the ſilk muſt be ſcoured, alumed, and

 waſhed;

waſhed; becauſe without aluming it would take only a reddiſh tinge, that would not ſtand wetting. To dye ſilk thus, it muſt be turned in a cold decoction of logwood, till it has acquired the proper colour: if the decoction were uſed hot, the colour would be in ſtripes and uneven.

Bergman has already obſerved, that a fine violet might be produced from logwood, by impregnating the ſilk with ſolution of tin, as has been ſaid in the preceding chapter. In fact, we may thus obtain, particularly by mixing logwood and braſil in various proportions, a great number of fine ſhades, more or leſs inclined to red, from lilac to violet.

If decoction of logwood be ſubſtituted for that of braſil in the proceſs communicated by Mr. Brown, a fine violet colour will be obtained; and if the two be mixed, we ſhall have ſhades of puce colour, and prune de monſieur, more or leſs inclining to red.

The remarks made on braſil are alſo applicable to logwood, the colouring matter of which exhibits ſimilar properties.

SECTION

SECTION IV.

Of Yellow.

CHAP. I.

Of Weld.

WELD or woald (*reseda luteola*, Lin.) is a plant very common in the environs of Paris, in most of the French provinces, and in a great part of the rest of Europe. It pushes out long narrow leaves, of a lively green: from the midst of these leaves the stalk rises to the height of three or four feet, frequently branchy, and furnished with leaves, narrow like the radical ones, but shorter as they approach the flowers, which are disposed in long spikes. The whole of the plant is used for dyeing yellow.

Two sorts of weld are distinguished. The bastard or wild, which grows naturally in the fields; and the cultivated, the stalks of which are smaller, and not so high. For dyeing, the

latter is preferred; it abounding more in colouring matter. The more ſlender the ſtalk, the more it is valued.

When the weld is ripe, it is pulled, dried, and made into bundles, in which ſtate it is uſed.

When the decoction of weld is very ſtrong, it has a yellow colour inclining to brown: if it be greatly diluted with water, its yellow, which is more or leſs pale, inclines a little to green.

If a little alkali be added to this decoction, its colour grows deeper, and after a certain time a little aſh-coloured precipitate falls down, which is not ſoluble in alkalis.

Acids in general render its colour paler, and occaſion a little precipitate, which will diſſolve in alkalis, giving them a yellow colour inclining to brown.

Alum forms with it a yellowiſh precipitate, and the liquor retains a fine lemon colour. If a ſolution of alkali be poured into this liquor, a whitiſh yellow precipitate, ſoluble in alkalis, is thrown down, but the liquor ſtill remains coloured.

Solution of common ſalt, or of muriat of ammoniac, renders the liquor turbid, and its colour at firſt a little deeper; by degrees a deep yellow precipitate forms, and the ſuper-

natant

natant liquor retains a pale yellow colour a little inclining to green.

Solution of tin produces a copious bright yellow precipitate: the liquor remains a long time turbid, but ſlightly coloured.

Sulphat of iron produces a plentiful dark gray precipitate, and the ſupernatant liquor is browniſh.

Sulphat of copper occaſions a browniſh green precipitate, and the liquor preſerves a pale green colour.

The yellow communicated to wool by weld has little permanency, if the wool be not previouſly prepared by ſome mordant. For this purpoſe alum and tartar are uſed, by means of which that plant gives a very pure yellow, which has the advantage of being permanent.

For the boiling, which is conducted in the common way, Hellot directs four ounces of alum to every pound of wool, and only one ounce of tartar: many dyers however, uſe half as much tartar as alum. Tartar renders the colour paler, but more lively.

For the welding, that is, for the dyeing with weld, the plant is boiled in a freſh bath, encloſing it in a bag of thin linen, and keeping it from riſing to the top by means of a heavy

wooden croſs. Some dyers boil it till it ſinks to the bottom of the copper, and then let a croſs down upon it: others, when it is boiled, take it out with a rake and throw it away.

Hellot directs five or ſix pounds of weld for every pound of cloth: but dyers ſeldom uſe ſo much, contenting themſelves with three or four pounds, or even much leſs. Many indeed, add to the weld a little quicklime and aſhes, which favour the extraction of the colouring matter, and heighten its colour, but at the ſame time render it liable to be changed by the action of acids. The quantity of weld however, ought to be proportionate to the depth of the ſhade to be obtained.

Lighter and brighter ſhades may be obtained by dyeing after deeper ones, adding water at each dipping, and keeping the bath boiling: but light ſhades procured in this way are not ſo lively as when freſh baths are uſed, proportioning the quantity of weld to the depth of the ſhade.

Common ſalt added to the weld bath renders its colour richer and deeper: ſulphat of lime, or gypſum, alſo deepens it: but alum renders it paler and more lively; and tartar, ſtill paler. Sulphat of iron or vitriol makes it incline to brown. The ſhades obtained from

from weld may be modified by ſuch additions, by the proportion of the weld, by the length of the operation, and by the mordants employed in preparing the ſtuff. Thus Scheffer ſays, that by boiling the wool two hours with a fourth its weight of ſolution of tin, and the ſame of tartar, waſhing it and boiling it fifteen minutes with an equal weight of weld, it will take a fine yellow, which however, will not penetrate its internal texture. Mr. Poerner alſo directs the cloth to be prepared as for dyeing ſcarlet. By theſe means greater brightneſs and permanency are given to the colour, which (cæteris paribus) is at the ſame time lighter.

The colour may be modified alſo by paſſing the cloth, when it comes out of the dye, through another bath. Thus, to produce a golden yellow, the cloth, when it comes out of the welding, may be paſſed through a ſlight madder bath; and for a tawny, (tannée) through a bath made with a little ſoot. Theſe methods will be mentioned in treating of ſaddenings.

To dye ſilk plain yellow, in general no other ingredient than weld is uſed. The ſilk ought to be ſcoured in the proportion of twenty pounds of ſoap to the hundred, and afterwards

alumed and refreſhed, that is, waſhed after the aluming.

A bath is prepared with two pounds of weld for each pound of ſilk, which after a quarter of an hour's boiling, is to be paſſed through a ſieve or cloth into a vat; when it is of ſuch a temperature as the hand can bear, the ſilk is put in, and turned until the colour is become uniform: during this operation the weld is boiled a ſecond time in freſh water; about half of the firſt bath is taken out, and its place ſupplied by a freſh decoction. This freſh bath may be uſed a little hotter than the former; too great a degree of heat however muſt be avoided, that no part of the colour already fixed may be diſſolved; it is to be turned as before, and in the mean time a quantity of cendres gravelées is to be diſſolved in a part of the ſecond decoction; the ſilk is to be taken out of the bath, that more or leſs of this ſolution may be put in, according to the ſhade required. After it has been turned a few times, a hank is wrung with the pin, that it may be ſeen whether the colour be ſufficiently full, and have the proper gold caſt: if it ſhould not, a little more of the alkaline ſolution is added, the effect of which is to give the colour a gold caſt, and to render

it

it deeper. In this way the proceſs is to be continued, until the ſilk has attained the deſired ſhade; the alkaline ſolution may alſo be added along with the ſecond decoction of the weld, always taking care that the bath be not too hot.

If we wiſh to produce yellows with more of a gold or jonquille colour, a quantity of annotta proportioned to the ſhade required, muſt be added to the bath along with the alkali.

For the light ſhades of yellow, ſuch as pale lemon, or canary-bird colour, the ſilk ought to be ſcoured as for blue, becauſe the ſhades are more beautiful and tranſparent, in proportion as the ground on which they are laid is whiter: the ſtrength of the bath is proportioned to the ſhade we wiſh to obtain; and if we intend that the yellow ſhould have a tinge inclining to green, more or leſs of the indigo vat is added, if the ſilk has not been azured. To prevent the ſhades from being too deep, the ſilk may be more ſlightly alumed than uſual.

Scheffer directs that the ſilk ſhould be ſoaked twenty-four hours in a ſolution of tin, made with four parts of nitric acid, one of common ſalt, and one of tin, and ſaturated with tartar; that it ſhould be waſhed, and boiled half an hour

hour with an equal quantity of weld flowers. He ſays, that a fine ſtraw colour is thus obtained, which poſſeſſes the advantage of reſiſting the action of acids. By following this proceſs, very little tin ſhould be left in the ſolution, becauſe the acid of tartar precipitates it.

In dyeing cotton yellow, we begin by ſcouring it in a bath prepared with the ley of the aſhes of green wood; it is then waſhed, dried, and alumed with one fourth of its weight of alum; after twenty-four hours it is taken out of the aluming, and dried without being waſhed. A weld bath is then prepared, with the proportion of a pound and a quarter of weld for each pound of cotton, in this the cotton is dyed, by being turned and wrought in it until it has acquired a proper ſhade; it is taken out of this bath to be ſoaked for an hour and a half, in a ſolution of ſulphat of copper or blue vitriol, in the proportion of one fourth of the weight of the cotton; it is then thrown, without being waſhed, into a boiling ſolution of white ſoap made with the ſame proportions; after being well ſtirred, it is boiled in it for nearly an hour, then well waſhed and dried.

If

If a deeper yellow be required, the cotton is not alumed, but two pounds and a half of weld for each pound of cotton are employed, to which a dram of verdegris mixed with a part of the bath is added; in this, the cotton is dipped and worked, until it has acquired an uniform colour; it is then taken out of the bath, that a little ley of soda may be poured in; returned into the bath and kept there for a full quarter of an hour, when it is taken out, wrung, and dried.

Lemon colour is dyed by the same process, except that only one pound of weld is employed for each pound of cotton, and that the proportion of verdegris may also be diminished, or even entirely omitted, aluming being substituted in its stead. The shades of yellow may thus be varied in many different ways. The processes for thread are the same.

For the yellow colours on printed cotton, the stuff is impregnated by means of engraved stamps, with the mordant described when treating of madder, made by the mixture of acetite of lead or salt of saturn and alum; the yellow colour, which the parts not impregnated with the acetite of alumine have acquired, is then discharged, by the action of bran and exposure on the grass. The same mordant

 might

might undoubtedly be employed with ſucceſs for cotton and linen to be dyed yellow.

CHAP. II.

Of Yellow-Wood, Fuſtic, Bois jaune[a].

THIS wood is obtained from a large tree *(Morus Tinctoria)* which grows in the Antilles, and principally at Tobago. It is of a yellow colour, as its name expreſſes, with orange veins. Its medullary productions are very ſmall, it is not very hard or heavy.

This wood has been extenſively uſed in dyeing only within theſe few years; it abounds much in colouring particles, and affords a very permanent colour, it unites well with indigo, and bears a moderate price; in ſhort, it poſſeſſes qualities which entitle it to a place among the moſt uſeful ingredients in dyeing.

[a] I have tranſlated bois jaune, fuſtic, becauſe the Mor. Tinct. is univerſally ſo called by our botaniſts, though V. de Bomare makes it the tulipifera. Vid. Hort. Kewens. T.

A ſtrong decoction of this wood is of a deep reddiſh yellow colour; when diluted with water, it becomes of an orange yellow. Acids with ſome ſlight differences, render this liquor turbid, a ſmall quantity of a greeniſh yellow precipitate is formed, the ſupernatant liquor is of a pale yellow: alkalis rediſſolve the precipitate, and give the liquor a deep reddiſh colour.

This is the colour which alkalis produce in a decoction of fuſtic, they deepen it much and make it almoſt red. After ſome time, a yellowiſh ſubſtance is ſeparated, which adheres to the veſſel, and ſometimes ſwims at the top.

Alum forms a ſmall quantity of a yellow precipitate, the liquor remains tranſparent but of a lighter yellow.

Alum and tartar produce a precipitate of the ſame colour, but which is more ſlowly formed, the colour of the liquor is ſtill paler.

Muriat of ſoda or common ſalt, makes the liquor ſomewhat deeper coloured, but without rendering it turbid.

Sulphat of iron forms a precipitate which is at firſt yellow, but afterwards becomes more and more brown, the liquor remains brown and turbid.

Sulphat

Sulphat of copper gives a great quantity of a browniſh yellow precipitate; the ſupernatant liquor remains of a very ſlightly greeniſh colour.

Sulphat of zinc gives a greeniſh brown precipitate, the liquor remains of a reddiſh yellow.

For uſe, yellow wood muſt be ſplit, or what is better, cut into chips, and encloſed in a bag, that no part of it may fix in the ſtuff and tear it.

Weld gives a cloth which has not been prepared, only a pale yellow, which ſoon changes in the air; but fuſtic without the aid of mordants gives it a browniſh yellow, which is dull indeed, but which ſtands very well when expoſed to the air; its colour is rendered more bright and fixed, by the mordants employed with weld, which act on it in a ſimilar manner; thus alum, tartar, and a ſolution of tin, render the colour brighter; common ſalt, and ſulphat of lime or gypſum, render it deeper. We may then treat fuſtic in the ſame way as weld, with only this difference, that in order to obtain the ſame ſhade, much leſs yellow wood is required; thus from five to ſix ounces of this wood are ſufficient to give a lemon colour to a pound of cloth, but the colours obtained

from

from it incline more to orange, than thoſe obtained from the weld; and therefore, they are ſometimes uſed together in quantities proportioned to the effect we wiſh to produce.

CHAP. III.

Of Annotta.

ANNOTTA, rocou, or roucou, is a ſomewhat dry, hard paſte, browniſh on the outſide, and of a fine red within; it is uſually brought to us in cakes of two or three pounds weight, wrapped up in very large reed leaves, from America, where it is prepared from the ſeeds of a certain tree (*Bixa Orellana*, Lin).

Father Labat ſays, that the Americans poſſeſs a ſpecies of annotta, which has a more beautiful and durable colour than that brought to us; and that in order to prepare it, they bruiſe the ſeeds with their hands moiſtened with oil, and detach with a knife, the paſte

that

that is formed, and then dry it in the ſun; whereas they prepare the annotta for ſale, by pounding the ſeeds with water, in which they are left to ferment. Annotta diſſolves much better and more eaſily in alcohol, than in water, hence it is employed in yellow varniſhes that are deſigned to have an orange caſt.

The watery decoction of annotta has a ſtrong ſmell, and a diſagreeable taſte, its colour is of a yellowiſh red, it is ſomewhat turbid; an alkaline ſolution changes it to an orange yellow, which is brighter and more pleaſing; a ſmall quantity of a whitiſh ſubſtance is ſeparated from it, which remains ſuſpended in the liquor. If we boil annotto in water with an alkali, it diſſolves much better than in water alone, and the liquor is of an orange colour.

Acids form with this liquor an orange-coloured precipitate ſoluble in alkalis, which communicate to it a deep orange colour; the ſupernatant liquor retains only a pale yellow.

Solutions of common ſalt and ſal ammoniac produce no ſenſible change.

The ſolution of alum gives a conſiderable quantity of orange precipitate, which is deeper than that which acids produce, the liquor remains of a pleaſant lemon colour, bordering a little on a green.

Sulphat

Sulphat of iron forms a precipitate of an orange brown; the liquor remains of a pale yellow.

Sulphat of copper gives a precipitate of a yellowish brown somewhat brighter than the former; the liquor preserves a greenish yellow colour.

A solution of tin produces a lemon-coloured precipitate, which is deposited very slowly.

When annotta is used, it is always mixed with an alkali, which facilitates its solution, and gives a colour less inclining to red. It is cut in pieces, and boiled in a caldron, with an equal weight of cendre gravelée, provided the desired shades do not require a smaller proportion of alkali; the cloth may be then dyed in this bath, either with these ingredients alone, or with the addition of others to modify the colour; but it seldom happens that annotta is used for wool, because the colours it imparts are too fading, and may be obtained of a more durable nature by other means. Hellot employed it in dyeing a stuff prepared with alum and tartar, but the permanency of the colour was not much increased, it is almost solely used for silk.

For silks to be dyed of an aurora, or orange colour, it is sufficient to scour them with twenty

pounds of ſoap to the hundred; after they have been well cleanſed, they may be immerſed in a bath of water, with which more or leſs of the alkaline ſolution of annotta (according to the ſhade required) has been carefully mixed. The heat of this bath ought to be between tepid and boiling water.

When the ſilk has acquired an uniform colour, one of the hanks muſt be taken out, waſhed and wrung, to ſee whether the colour be ſufficiently full, and if it be not, more ſolution of annotta muſt be added, and it muſt be turned again. This ſolution preſerves its colour unchanged.

When the deſired ſhade has been obtained, nothing remains but to waſh the ſilks, and to beetle them twice, by a ſtream of water, to free them from the ſuperfluous annotta, which would injure the beauty of the colour.

When raw ſilk is to be dyed, ſuch as is naturally white muſt be choſen, and it muſt be dyed in the annotta bath, which ought only to be tepid, or even cold, that the alkali may not diſſolve the gum of the ſilk, and deſtroy its elaſticity, which we wiſh to preſerve.

What has been now ſaid reſpects the ſilk intended to receive the aurora colour: to make the orange, which contains more red, after

dyeing

dyeing with annotta, it is neceſſary to redden the ſilks with vinegar, alum, or lemon juice. The acid, in ſaturating the alkali uſed to diſſolve the annotta, deſtroys the yellow ſhade which the alkali had imparted, and reſtores its natural colour, which inclines a good deal towards red.

For the very deep ſhades, it is the practice at Paris, as Mr. Macquer informs us, to alum them; and if the colour is not yet red enough, to paſs them through a weak bath of braſilwood. At Lyons, the dyers, who uſe carthamus, ſometimes employ the old baths made with that ingredient for the deep orange colours.

When orange colours have been reddened with alum, they muſt be waſhed in a ſtream of water, but it is not neceſſary to beetle them, unleſs the colour be too red.

Shades which preſerve a reddiſh hue may likewiſe be obtained by a ſingle operation, namely, by employing in the preparation of the annotta bath, a ſmaller quantity of alkali than that above directed.

Mr. Guhliche adviſes us not to employ heat in the preparation of annotta. He directs that it ſhould be put into a glaſs veſſel, or one of earthen ware with a vitreous coat, and that as much

 ſolution

ſolution of pure alkali ſhould be added as will cover it, and that this mixture ſhould be left at reſt for twenty-four hours; that the liquor ſhould then be decanted, and filtered, and the reſiduum repeatedly waſhed with water, leaving the mixture at reſt each time for two or three days, till the water no longer receives any colour; that theſe liquors ſhould be all mixed together, and put into a well ſtopped veſſel and kept for uſe.

He directs that the ſilk ſhould be ſteeped for twelve hours in a ſolution of alum, in the proportion of two ounces of the ſalt to a pound of the ſilk, or in water acidulated with the aceto-citric acid before deſcribed; when taken out of this mordant, it is to be well wrung.

The ſilk thus prepared is put into the annotta bath quite cold, and kept there, and ſtirred about, until it has acquired the proper ſhade, or it is kept at a degree of heat far below ebullition; when taken out of the bath, it is waſhed and dried in the ſhade.

For the brighter ſhades, a liquor is employed, which is leſs loaded with colour, to which may be added a little of the acid liquor, which has been uſed as a mordant, or the dyed ſilk may be paſſed through acidulated water.

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If we wiſh to have the laſt ſhades with leſs of an orange caſt, and approaching to nankeen, a ſmall quantity of ſolution of galls in white wine may be added to the bath.

To give an orange colour to cotton, Mr. Wilſon directs the annotta to be ground while it is kept moiſtened, boiled in water with double its weight of alkali, left to ſettle for half an hour, and the clear liquor to be put into a heated veſſel; in this, the cotton is to be immerſed, when it will take an orange colour. A hot ſolution of tartar is then to be poured into the bath, ſo that it may become weakly acidulated, it is to be again turned in it on the ſkein ſticks, or wound upon the winch when in the piece; in this way, the colour becomes more lively, and fixes better; they then waſh the cotton ſlightly and dry it in a ſtove.

CHAP. IV.

Of Saw-wort and ſeveral other Subſtances which dye Yellow.

SAW-WORT (ſarette) *ſerratula tinctoria*, is a plant which grows abundantly in meadows and woods. Without mordants, it gives a yellowiſh green colour which has no durability; but by means of alum, employed either in a ſeparate boiling, or put into the bath with the ſaw-wort, it gives a yellow colour which is both pleaſing and durable. According to Mr. Poerner, the beſt mordants for it, are alum, and ſulphat of lime. It is unneceſſary to repeat, that the latter produces the deepeſt colour, the ſhade of which may alſo be varied by the proportions of mordant and ſaw-wort. Scheffer directs that the wool ſhould be prepared with alum and one-twelfth of tartar: he ſays, that if it be prepared with three-ſixteenths of ſolution of tin and as much tartar, it acquires a much brighter colour than in the former caſe.

Dyers broom, or dyers weed, (la geneſtrole) *geniſta tinctoria*, which grows plentifully in dry and

and mountainous ſoils, gives a yellow colour, not comparable in beauty to that of weld, or ſaw-wort, but which becomes ſufficiently fixed by means of mordants, the moſt advantageous of which, either for the preparation of the cloth, or for being put into the bath, are tartar, alum, and ſulphat of lime.

Camomile (anthemis tinctoria) *camomilla matricaria*, a well known plant, gives a weak yellow colour of a tolerably pleaſant hue, but without durability; mordants give it a little; the moſt uſeful of theſe are alum, tartar, and ſulphat of lime.

According to Scheffer, a very fine yellow may be given to ſilk with a decoction of this plant, into which a little ſolution of tin mixed with tartar till its colour is become yellow, has been added drop by drop; for dyeing the ſilk, it is kept warm, but without boiling: he recommends that good water which does not precipitate ſolution of tin ſhould be employed.

Fenugreek *(trigonella fœnugræcum)* affords ſeeds, which when ground, are capable of giving a pale and tolerably durable yellow: the mordants which ſucceed beſt with this ſubſtance, are alum, and common ſalt.

Turmeric (terra merita) *curcuma longa*, is a root brought to us from the Eaſt-Indies. I have

had an opportunity of examining ſome turmeric which came from Tobago, which was ſuperior to that which is met with in commerce, both in the ſize of the roots, and the abundance of colouring particles. This ſubſtance is very rich in colour, and there is no other which gives a yellow colour of ſuch brightneſs, but it poſſeſſes no durability, nor can mordants give it a ſufficien degree: common ſalt and ammoniacal muriat are thoſe which fix the colour beſt, but they render it deeper, and make it incline to brown, ſome recommend a ſmall quantity of muriatic acid. The root muſt be reduced to powder to be fit for uſe. It is ſometimes employed to give the yellows made with weld a gold caſt, and to give an orange tinge to ſcarlet; but the ſhade the turmeric imparts ſoon diſappears in the air.

Mr. Guhliche gives two proceſſes for fixing the colour of turmeric on ſilk. The firſt conſiſts in aluming in the cold for twelve hours, a pound of ſilk in a ſolution of two ounces of alum, and dyeing it hot, but without boiling, in a bath compoſed of two ounces of turmeric, and a quart (meſure) of aceto-citric acid mixed with three quarts of water. The ſecond proceſs conſiſts in extracting the colouring particles from the turmeric by aceto-citric

acid,

acid, in the way defcribed for brafil-wood, and in dyeing the filk alumed as already mentioned in this liquor, either cold, or only moderately warm. The colour is rendered more durable by this, than by the former procefs. The firft parcel immerfed acquires a gold yellow; the colour of the fecond and third parcels are lighter, but of the fame kind; that of the fourth is a ftraw colour. Mr. Guhliche employs the fame procefs to extract fine and durable colours from fuftic, broom, and french berries: he prepares the wool by a flight aluming, to which he adds a little muriatic acid; he feems to content himfelf in thefe cafes with vinegar or fome other vegetable acid, inftead of his aceto-citric acid for the extraction of the colour; he directs that a very fmall quantity of folution of tin fhould be put into the dye-bath.

Venus's fumach (fuftet) *rhus cotinus* [a], is a wood the colour of which is orange and greenifh, with fibres of a fhining appearance; it is made ufe of in the form of chips.

[a] According to the beft intelligence I can obtain from our dyers, they never employ this fubftance; the morus tinctoria, or bois jaune, being among them diftinguifhed by the name of fuftic. T.

This

This wood gives a fine orange colour poſſeſſed of no durability ; ſo that it is not employed alone but mixed with other colouring ſubſtances, particularly cochineal, to give a fire colour to ſcarlet, for pomegranates, jujubes, langouſtes, oranges, jonquilles, gold colours, buffs, and in general for all thoſe colours which it is wiſhed ſhould have ſomewhat of an orange hue. The advantage derived from the uſe of this ſubſtance is, that its colour is weakened and diſcharged, without the hue being changed ; beſides, when it is united with other colours it is more durable than when alone.

French berries (la graine d'Avignon) *rhamnus infectorius*, gives a pretty good yellow but void of durability ; when employed, the cloth is prepared in the ſame manner as for dyeing with weld.

The leaves of the willow are mentioned by Scheffer as proper for giving a fine yellow colour to wool, ſilk, and thread. Bergman aſſerts that the leaves of the ſweet willow (laurier ſaule) *ſalix pentandra*, ſhould be employed, and that the leaves of the common willow give a colour, which is for the moſt part diſcharged by the ſun in a few weeks.

Scheffer directs that the wool ſhould be left a whole night in a cold ſolution of three ounces of

of alum, and one ounce of tartar to the pound. The boiling is made with leaves gathered about the end of Auguſt or beginning of September, dried in a ſhady but airy place: as much of theſe as is thought proper is boiled for half an hour, and half a dram of white pot-aſh for each pound is added, to render the colour more bright and deep, and the bath is paſſed through the ſieve; it is kept nearly boiling, and the wool left in it, until it has taken the deſired colour. He directs the ſame proceſs for ſilk, and for thread, except that the proportion of alum is increaſed an ounce per pound. According to Bergman's account, Mr. Alſtroemer has obſerved that the colour was rendered richer by ſoaking the thread with ſix ounces of alum, wringing and drying it, before being dyed; and that half an ounce of pot-aſh per pound was required, for the complete extraction of the colouring matter.

According to M. d'Ambourney, the bark and more eſpecially the young branches of the Italian, and ſome other ſpecies of poplar, give wool a beautiful and permanent yellow, particularly when it has been prepared with ſolution of tin; nearly ſeven parts by weight of this wood, are required to dye one of wool.

The feeds of purple trefoil *(trifolium pratenſe purpureum majus,* Raii.) are employed in dyeing, in England and Switzerland. Mr. Vogler has endeavoured to diſcover what colours might be obtained from them; and has found that a bath of this feed and ſolution of pot-aſh, afforded a ve y deep yellow; with ſulphuric acid, a l ght yellow; wi:h ſolutions of alum and tin, a lemon colour; with ſulphat of copper, a greeniſh yellow. Wools impregnated with theſe mordants, and boiled for ſome minutes in a bath of red trefoil ſeed, are found to be permanently dyed of the colours above mentioned; theſe yellows give a fine green with indigo: lucern *(medicago ſativa)* afforded Mr. Vogler the ſame reſults [b].

M. Dizé has made experiments of compariſon on trefoil and weld [c]: whence it appears that the trefoil ſeed gives wool a fine orange yellow, and ſilk a greeniſh yellow; that ſolution of tin cannot be employed in this dye, but that aluming is neceſſary; laſtly, that the blue applied upon the yellow produced by the trefoil, gives a leſs beautiful, and more

[b] Ann. de Chym. tom. iii. [c] Journ. de Phyſ. 1789.

3 dull

dull green, than that for which weld has been employed.

Common Canada golden rod *(ſolidago canadenſis)* had already been recommended by Hellot. M. Gaad had remarked in the Stockholm memoirs, that this plant afforded a yellow colour even ſuperior to that of weld, and greatly preferable to that of dyers-weed; as however, its uſe has not been adopted, though the plant is eaſily cultivated, M. Succow has ſubjected it to freſh trials. I ſhall paſs over the experiments with reactives, which afford nothing particular. A decoction of the ſtalks of this plant, to which the author had added a conſiderable proportion of alum, gave a pattern of cloth which had received no preparation, a very lively ſtraw colour; to another pattern prepared with ſulphat of iron, a greeniſh yellow; and a very pure and lively lemon colour to a third pattern, which had been prepared with alum.

The flowers of french marygold *(tagetes patula)* ſeparated from their calices, were ſubjected to the ſame trials. The cloth without preparation acquired a deep yellow colour in a decoction of theſe flowers; when prepared with ſulphat of iron, a greeniſh colour, which by a continuance of boiling became very deep; finally, cloth

cloth prepared with alum, acquired a very bright yellow inclining a little to green. If a little alum be added to the bath before the ſtuff is put in, a very fine and lively yellow is obtained, which has even more brightneſs than that produced by the Canada golden rod.

Dr. Bancroft has made known the uſe of the bark of a kind of oak, called yellow oak, in New-England, and has obtained an excluſive right to the traffick of this bark in France and England: he calls it quercitron[d].

According to Dr. Bancroft, the quercitron bark may be advantageouſly ſubſtituted for weld in the printing of linens, but it muſt be only ſimply infuſed in warm water, and only one part employed, inſtead of ten of weld.

To dye wool yellow, Dr. Bancroft adviſes that ſolution of tin and alum ſhould be put into the bath with the quercitron. Silk ought to be treated in the ſame manner as with weld: if a very bright yellow is required, it muſt be prepared with ſolution of tin.

It appears from ſome information for which I am indebted to Mr. Brown, that many manufacturers of printed linens in England, at preſent prefer this bark to weld, becauſe it

[d] Inſtructions, &c.

is confiderably cheaper and the ground whitens more eafily. Some find it advantageous to mix a certain proportion of decoction of weld with the quercitron bath, which fhould be expofed to only a gentle heat. M. d'Ambourney afferts, that to obtain the advantages fet forth by Dr. Bancroft, the wool muft be firft prepared with folution of tin, and then his procefs followed.

There is a great number of other fubftances which are employed to dye yellow, and which afford fhades endued with different degrees of beauty and durability; of this fort is the bark of the berberry (l'epine-vinette), wild chervil, or cow-weed (cerfeuil fauvage), common fting-ing-nettle (grande ortie), the root of p·tience dock (patience fauvage), bark of the afh (frêne), the leaves of the almond, peach, and pear-tree, flowers of common furze (jonc marin), &c. We have alfo feen in the firft part of this work that the nitric acid might be employed to produce a yellow colour.

According to the obfervations of Lewis, white flowers give even a deep yellow colour to the water in which they are boiled; acids, alkalis, and other falts have the fame effect upon this colour, as upon thofe of other

yellow

yellow vegetable ſubſtances *. Mr. Guhliche gives a proceſs for dyeing ſilk of a ſtraw colour, with the white flowers of the acacia, ſuch as is difficultly obtained in equal perfection by other ſubſtances. Having collected theſe flowers and dried them in the ſhade, he ſubmitted them to a ſlight roaſting, keeping them ſtirred in a veſſel heated by means of live coals; when they have become yellow, he adds to them ſuch a quantity of lime water as takes a pretty deep colour; he digeſts this mixture in a gentle heat, until the flowers are become white, and then filters the liquor. For a pound of ſilk, he adds to a bath made with four ounces of dry flowers, half an ounce of powdered oyſter ſhells, two drams of alum, or a little aceto-citric acid. In this bath while ſtill warm, he dyes the ſilk, which has either received a very ſlight aluming, or has been ſteeped in the acid liquor; a little ſolution of indigo produces a beautiful ſhade of light green with this yellow.

It appears that the ſubſtances which may be employed to dye yellow are very numerous; they differ from each other in the quantity of their colouring matter, in their dye being

* The chemical works of Caſpar Neumann.

more

more or leſs free, more or leſs inclining to orange or green, in poſſeſſing different degrees of brightneſs and durability, and in their price. Theſe properties taken together, ought to regulate our choice, according to the quantity of the ſtuff, the colour required, and the particular circumſtances in which we are placed.

In general, alkalis render the colour of theſe ſubſtances deeper and more of an orange caſt; they facilitate the extraction of the colouring particles; it is indeed only by means of them that we obtain the particles from annotta, but they alſo favour their deſtruction. Sulphat of lime or gypſum, common ſalt, and ſal ammoniac render the colour of yellow ſubſtances deeper; acids render it more clear and more durable; alum and ſolution of tin, while they render it more clear, alſo confer greater brightneſs and durability. Silk may be advantageouſly prepared with ſolution of tin; as we have ſeen that it ought to be, in order to take a durable colour from braſil and logwood.

SECTION V.

Of Fawn Colour (fauve).

I SHALL give an analyſis of only ſome of the ſubſtances employed to produce fawn colours; becauſe the number of thoſe which may be employed, is too great to admit of a particular examination of each, and they bear ſo near a reſemblance to each other, that the obſervations made on ſome will apply to the remainder.

CHAP. I.

Of Walnut-Peels.

WALNUT-PEELS form the green covering of the nut: theſe, it is well known, are white internally, but grow brown or black when expoſed to the air, whence it happens,

happens, than when the ſkin has been impregnated with their juice, it ſoon aſſumes a brown or almoſt black colour.

If the internal part of the freſh peel be immerſed in very weak oxygenated muriatic acid, it alſo acquires a brown colour in that fluid.

The filtered decoction aſſumes a deep brown colour in the air; on evaporation, it affords pellicles which, when removed, well waſhed, and dried, are nearly black; the liquor ſeparated from the pellicles affords a brown extract, which may be rediſſolved completely in water, but which by a freſh evaporation, again yields pellicles ſimilar to the former.

Theſe pellicles which are formed in many other evaporations, are owing to the colouring matter, the properties of which have been changed by a ſlight combuſtion.

Alcohol precipitates the colouring particles from the decoction of walnut-peels, in the form of a brown ſubſtance, which may be rediſſolved in water.

Solution of pot-aſh produces no ſenſible change at firſt, in the decoction of walnut-peels; by degrees it grows a little turbid, and the colour becomes deeper.

The muriatic acid rendered the colour more clear, and reduced it to a yellow; a little brown precipitate was formed, and the liquor remained of a clear yellow.

Solution of tin produced in the decoction a copious fawn coloured precipitate, inclining to an ash colour; the liquor retained only a slight yellow colour.

Solution of alum rendered the liquor slightly turbid; a very little brownish fawn coloured precipitate was formed, the liquor had a lighter hue, but was still fawn coloured.

Solution of sulphat of copper rendered this liquor turbid very slowly; a small quantity of brownish green sediment was formed; the supernatant liquor remained green.

Acetite of lead quickly produced a copious precipitate of a deep fawn colour.

Solution of sulphat of iron rendered the colour much deeper and even black; by dilution with water it was changed to brown, and to a greenish fawn colour, but no sediment was formed.

Solution of common vitriol of zinc rendered the colour much deeper, but produced no precipitate.

Solution of pure ſulphat of zinc only rendered the liquor ſlightly turbid; by which its colour was a little darkened.

A decoction of walnut-tree root exhibits very nearly the ſame properties: when the bark was ſeparated from the ligneous part of the root, an equal weight of the former afforded a liquor much more loaded with colour. The bark of the wood of the walnut-tree alſo exhibited properties reſembling thoſe of the walnut-peels, but its decoction formed a blackiſh precipitate with ſulphat of iron.

I have found that walnut-peels had a briſk action on oxyd of iron; they diſſolve it and form a black liquor like ink; if they be boiled with pure filings of iron, theſe are not acted upon, but when left expoſed to the air, the liquor ſoon becomes black.

The colouring particles of walnut-peels have a ſtrong diſpoſition to combine with wool, and give it a very durable hazel or fawn colour; mordants appear to add little to its durability, but are capable of varying its ſhades, and giving them greater brightneſs. By means of alum in particular, when the ſtuff is prepared with it, a richer and more lively colour is obtained.

The uſe of walnut-peels is very advantageous, for they give ſhades which are ſufficiently pleaſing, and very durable; and as they are employed without a mordant, they preſerve the ſoftneſs of the wool, and require only a ſimple and very cheap proceſs.

The peels are gathered when the nuts are perfectly ripe, and large caſks are filled with them, and as much water added as will cover them. In this ſtate they are kept a year or more at the Gobelins, where the uſe of them is very extenſive and various; they are preſerved for two years before they are uſed: it is found that they then yield much more colour. They have a very diſagreeable putrid odour.

The peel ſeparated from the nuts before they are ripe may alſo be employed, but it does not keep ſo long.

When walnut-peels are to be employed for dyeing, a quantity, proportioned to that of the ſtuff and the depth of the ſhade required, is boiled for a full quarter of an hour in a copper. In cloths, the deepeſt ſhades are commonly dyed firſt, and the lighter ones afterwards; but for woollen yarn, the light ſhades are generally dyed firſt, and the deeper ones afterwards, freſh peels being added for each

each parcel. Cloth and yarn ſhould be ſimply moiſtened with warm water before they are put into the copper, where they are carefully ſtirred until they have acquired the proper ſhade, unleſs they have had a previous aluming.

The root of the walnut-tree gives the ſame ſhades, but for this purpoſe, the quantity muſt be increaſed; it muſt be reduced to chips, and ſhould be put into a bag, that the ſmall bits may not ſtick to the ſtuff. It readily happens that the colour turns out unequal and ſpotted: to avoid this inconvenience, the fire muſt be kept low at the beginning, that the colouring particles may be diſtributed through the bath, in proportion as they are extracted from the root. If any of the parts ſhould be dyed unequally, as the colour is a fixed one, there is no other remedy, but to reſerve the ſtuff for a deeper colour.

I have dyed different patterns of wool with decoction of walnut-peels, adding to one, oxyd or calx of tin, to another, oxyd or flowers of zinc, to a third, ſemivitrified oxyd of lead or litharge, to a fourth, oxyd of iron. The quantity of decoction, weight of the pattern, time of boiling, and all other circumſtances were equal, both with reſpect to theſe, and

another pattern which was treated without addition, and intended to ſerve as a ſtandard of compariſon; the oxyd of tin gave a more clear and bright fawn colour, than that of the ſtandard; the oxyd of zinc a colour ſtill more clear, and approaching to an aſh-coloured gray; the oxyd of lead, a colour with more of an orange caſt; the oxyd of iron, a greeniſh brown colour.

CHAP. II.

Of Sumach, and ſome other Subſtances proper for giving a Fawn Colour.

COMMON ſumach *(rhus coriaria)* is a ſhrub that grows naturally in Syria, Paleſtine, Spain, and Portugal, in the two laſt it is cultivated with great care; its ſhoots are cut down every year quite to the root, and after being dried, they are reduced to powder by a mill, and thus prepared for the purpoſes of

of dyeing and tanning. The ſumach cultivated in the neighbourhood of Montpellier is called rédoul or roudou.

The infuſion of ſumach, which is of a greeniſh fawn colour, ſoon becomes brown by expoſure to the air: a ſolution of pot-aſh produces but little change on it while recent; acids brighten its colour and turn it yellow; ſolution of alum renders it turbid, and produces in it a ſmall quantity of yellow precipitate; the liquor remains yellow.

Acetite of lead produced immediately a conſiderable quantity of yellowiſh precipitate, the ſurface of which was brown; the liquor remained of a clear yellow.

Sulphat of copper produced a copious precipitate of a yellowiſh green, which after ſome hours changed to a browniſh green; the liquor remained clear and ſlightly yellow.

Common ſulphat of zinc rendered the liquor turbid, darkened its colour, and produced a deep blue precipitate.

Pure ſulphat of zinc did not deepen the colour nearly ſo much, only a ſmall quantity of a browniſh fawn-coloured precipitate was produced.

Muriat of ſoda or ſea ſalt, at firſt produced no ſenſible change; but after ſome hours, the liquor

liquor became ſomewhat turbid, and its colour was renderd a little more clear.

Sumach acts on a ſolution of ſilver juſt as galls do, it reduces the ſilver to its metallic ſtate, and the reduction is favoured by the action of light. I have elſewhere enlarged on the explanation of this phenomenon, and the inferences to be drawn from it.

Of all aſtringents, ſumach bears the greateſt reſemblance to galls: the precipitate however, produced in ſolutions of iron, by an infuſion of it, is leſs in quantity than what is obtained by an equal weight of galls, ſo that in moſt caſes, it may be ſubſtituted for galls, the price of which is conſiderable, provided we proportionally increaſe its quantity.

Sumach alone gives a fawn colour inclining to green; but cotton ſtuffs which have been impregnated with printers mordant, that is acetite of alumine, take a pretty good and very durable yellow. An inconvenience is experienced in employing ſumach in this way, which ariſes from the fixed nature of its colour; the ground of the ſtuff does not loſe its colour by expoſure on the graſs, ſo that it becomes neceſſary to impregnate all the ſtuff with different mordants to vary the colours, without leaving any part of it white.

The

The bark of the birch tree*, *(betula alba)* affords a decoction of a clear fawn colour, which soon becomes turbid, and changes to a brown; by exposure to the air with a solution of alum, a yellow precipitate in considerable quantity is formed; with a solution of tin, a copious precipitate of a clear yellow colour is produced; it blackens the solutions of iron, producing a considerable quantity of precipitate, so that it contains a good deal of the astringent principle: it dissolves a pretty large quantity of oxyd or calx of iron; hence arises the custom of employing it in the black vats intended for dyeing thread; it does not however possess the property of dissolving iron, in the same degree as the decoction of walnut-peels does.

The number of substances which are capable of producing fawn colours, might be greatly extended; almost all vegetables containing, (particularly in their bark) a greater or less quantity of colouring particles, fitted for giving different shades of fawn colour, inclining to yellow, brown, red, or green. These colouring particles vary in quantity, and even in quality, according to the age, the kind of

* According to the author, ecorçe de l'aune. T.

vegetable,

vegetable, and the climate in which it grows. Great variety of ſhades may be produced, by modifying the natural fawn colour of vegetables, by means of different mordants. This has been carried into execution by Mr. Sieffert[b], and particularly by Mr. d'Ambourney[c]. In the great number of experiments which Mr. d'Ambourney has made with different vegetables, modified by different mordants, we obſerve, that the colours which he produced are for the moſt part between a yellow and brown, ſuch as carmelites, olives, cinnamons, and marrones.

The decoction of moſt vegetables, and particularly of their bark, not only affords the ſame colour, differing only as to ſhade, but alſo ſhews nearly the ſame properties with reactives; with alum, it forms a more or leſs deep yellow precipitate, and with ſolution of tin, a clearer yellow: on ſolutions of iron, it acts as an aſtringent; decoction of walnut-peels however affords a ſingular exception with reſpect to ſolution of iron: it aſſumes a very

[b] Verſuche mit einheimiſchen farbe materien.

[c] Recueil de procédés & expériénces ſur les teintures ſolides que nos végétaux indigenes communiquent aux laines, & aux lainages.

deep

deep colour, but no precipitation takes place, even after three or four days.

It would appear that this property of walnut-peels, which is alſo obſervable in the root of the walnut-tree, depends on the tendency which its compound with the oxyd of iron has, to remain united with the acid; for the decoction has a powerful action on the oxyd of iron, it becomes ſaturated with it, and forms a black liquor, and if even filings of iron be put into this decoction, left expoſed to the air, a black liquor is formed in two or three days, by means of the oxygen it attracts from the atmoſphere. If the decoction with the addition of ſulphat of iron be boiled, a conſiderable quantity of black precipitate is inſtantly formed. It is only then in a very trifling circumſtance, that walnut-peels and the bark of the walnut-tree differ from the other ſubſtances which afford a fawn colour; but their extractive part poſ-ſeſſes in a remarkable degree, the property of growing black by the action of the air, and the pellicles which it has formed when it is evaporated, acquire in a very marked degree the appearance of a coaly ſubſtance.

I have endeavoured to give the rationale of thoſe general properties of the ſubſtances which produce a fawn colour, and which muſt, in a greater

greater or leſs degree, be looked upon as aſtringents[d]: I have conſidered them to be the produce of the colouring ſtubſtance formed in the leaves and flowers, and which entering into the circulation which is proper to vegetables, have undergone, both by the action of the external air, and of that contained in the air veſſels of vegetables, a ſpecies of combuſtion, by which their hydrogen is diminiſhed and their carbonaceous principle becomes predominant.

If the yellow colour which many vegetable ſubſtances produce, be compared with the fawn colour which moſt of them yield, a near connection will be found between theſe colours; there are even ſome which may be referred equally to yellow or to fawn colour: there are ſome which are fawn coloured, but which by means of alum and ſolution of tin become yellow, and theſe yellows are very durable. This difference may be eſtabliſhed between them: the yellows are in general leſs fixed, and more liable to give fading colours; becauſe they have not been reduced to a permanent ſtate, by a combuſtion ſo far advanced as that which the fawn colours have undergone; and therefore the colour of yellow ſubſtances requires to

[d] Ann. de Chym. tom. vi.

be

be fixed by means of mordants, whereas, moſt fawn-coloured ſubſtances yield of themſelves a colour which is ſufficiently durable.

As the fawn-coloured ſhades obtained from different ſubſtances vary even to a great extent, ſeveral of theſe ſubſtances are ſometimes mixed together in different proportions, to produce a particular colour; they are alſo mixed with other ſubſtances, to modify the colour obtained from them, and to make it more fixed.

Among theſe ſubſtances there is ſtill one which merits attention, that is *ſaunders* or *ſandal*.

Three ſorts of ſaunders are diſtinguiſhed, the white, the yellow, and the red; the laſt is the only one employed in dyeing: it is a ſolid, compact, heavy wood, brought to us from the coaſt of Coromandel, which grows brown by remaining expoſed to the air: it is commonly employed ground into very fine powder; it gives a fawn colour with a browniſh caſt inclining to red; of itſelf it gives little colour, and it is ſaid to make the wool harſh; but its colouring matter diſſolves better when it is mixed with other ſubſtances, ſuch as walnut-peels, ſumach, and galls; beſides, the colour which it gives is durable, and advantageouſly modifies thoſe of other ſubſtances with which it is mixed.

Mr. Vogler

Mr. Vogler having obſerved, that diluted alcohol or brandy diſſolved the colouring matter of ſaunders much better than water, employed this ſolution, both alone and mixed with ſix or ten parts of water, to dye patterns of wool, ſilk, cotton, and thread, which had been previouſly prepared by being impregnated with the ſolution of tin, and afterwards waſhed and dried. Theſe patterns took all of them alike a poppy colour. Patterns of the ſame kind prepared with alum, alſo took a rich ſcarlet colour; prepared with ſulphat of copper, a fine clear crimſon colour; prepared with ſulphat of iron, a beautiful deep violet [e].

With the ſpirituous liquor he dyed in the cold, but employed a gentle degree of ebullition with that which had been mixed with water; this mixture takes place without injuring its tranſparency.

Soot is likewiſe employed to give wool a fawn colour, or a brown, which is more or leſs deep according to the proportion of that ſubſtance which is employed; but ſoot gives only a fading colour, becauſe it only attaches itſelf feebly to the wool inſtead of combining with it; it renders it harſh and leaves a diſagreeable

[e] Crell. Ann. 1790.

ſmell:

ſmell: it is uſed however for browning certain colours in ſome manufactories of eminence; no doubt becauſe certain ſhades may be obtained by it, which would be difficultly got by other means.

SECTION VI.

Of Compound Colours.

THAT compound colours are formed by the admixture of ſimple ones, is well known; and if the colouring particles were not liable to vary in their effects, according to the combinations they form, and the influence exerted on them by the different ſubſtances contained in the baths, the ſhade which ſhould reſult from the mixture of two colours or ſubſtances which would produce theſe colours when unmixed, might be determined with accuracy; but the chemical action of mordants, and of the liquor of the bath, frequently change the reſults; theory however may be extended to theſe effects.

We muſt not conſider as a conſtituent part of compound colours that which is natural to the colouring particles, but that which they ought to aſſume with a particular mordant, and in a particular bath, ſo that our attention muſt be principally fixed on the effects of the chemical agents we employ.

It

It is in this part of dyeing that the knowledge of the artiſt may be moſt uſeful, by enabling him to vary his proceſſes according to the fantaſtical changes of the faſhion, and to arrive at the end propoſed in his operations, by the moſt ſimple, ſhort, and cheap means.

The proceſſes for compound colours are very numerous. I ſhall mention only thoſe which have appeared to me moſt worthy of attention, and ſhall endeavour more eſpecially to eſtabliſh by examples, the principles by which we ought to be guided. I have already in the courſe of the work deſcribed many proceſſes for colours which may be conſidered as compound ones, becauſe I did not think it right to confine myſelf ſtrictly to a plan, which involved the neceſſity of ſeparating operations nearly connected with each other.

CHAP. I.

Of the Mixture of Blue and Yellow, or Green.

MANY different plants are capable of affording green colours, ſuch as the field broom-graſs (coquiole noire) *bromus ſecalinus*, the green berries of the berry-bearing alder (bourdaine) *rhamnus frangula*, wild chervil or cow-weed (cerfeuil ſauvage) *chærophyllum ſylveſtre*, purple or honeyſuckle clover (le trefle des prés) *trifolium pratenſe*, common reed (le roſeau) *arundo phragmitis*; but theſe colours are not permanent.

M. d'Ambourney however aſſerts, that he has obtained a permanent green from the fermented juice of the berries of the berry-bearing alder; he prepared the cloth with tartar, nitrous ſolution of biſmuth, and common ſalt, and added to the fermented juice of the berries when warmed, a little acetite of lead: the cloth acquired in this bath a middle ſhade between parrot and graſs green.

It

It is by the admixture of blue and yellow, that the dyers make green, which is diftinguifhed into a great number of different fhades; it requires addrefs and experience to obtain this colour uniform and without fpots, particularly in the light fhades.

Green may be produced by beginning either with the yellow or the blue dye; but the firft method is attended with fome inconveniencies, for the blue foils the linen, and a part of the yellow being diffolved in the vat, changes and makes it green; the fecond method is therefore prefered.

The paftel vat is commonly employed, but for fome kinds of green, folution of indigo in the fulphuric acid is ufed; and then, the blue and yellow are either dyed feparately, or all the ingredients are mixed together, to dye by a fingle operation; finally, folutions of copper with yellow fubftances may be employed. We fhall briefly mention the different proceffes.

The blue ground ought to be proportioned to the green we wifh to obtain; thus for the green, like that of a drake's neck, (verd canard) a ground of deep royal blue is given; for parrot green, a ground of fky blue; for verd naif-

ſant, a ground of whited blue (bleu blanchi) is given.

When the cloths have received the proper ground they are waſhed in the fulling mill, and are boiled as for common welding, but for the light ſhades, the proportion of ſalts is diminiſhed. Moſt commonly the cloths intended for the light ſhades are boiled firſt; and when theſe are taken out, tartar and alum are added; and this practice is purſued until we come to the cloths intended for the darkeſt ſhades, more and more tartur and alum being always added.

The welding is conducted in the ſame manner as for yellow; but a larger quantity of weld is employed, unleſs for the lighter ſhades, which on the contrary require a ſtill ſmaller proportion. For the moſt part, a ſucceſſion of ſhades from the deepeſt to the lighteſt is dyed at the ſame time, beginning with the deepeſt and proceeding to the lighteſt: between each dip, which laſts half an hour, or three quarters, water is added to the bath. Some dyers give each parcel two dips, beginning the firſt time with the deep ſhades, and the ſecond with the light ones; in that caſe each parcel ſhould remain a ſhorter time in the bath: for the

the very light ſhades, we muſt take care that the bath does not boil.

To the very deep greens a browning with logwood and a little ſulphat of iron is given.

In ſilk it is ſtill more difficult to prevent the green from being ſpotted or ſtriped than in cloth. The ſcouring of the ſilk intended for greens, is conducted in the ſame manner as for common colours; for the light ſhades however it muſt be thoroughly ſcoured as for blue.

Silk is not firſt dyed blue like cloth, but after being well alumed, it is ſlightly waſhed at the river, and divided into ſmall hanks that it may take the dye uniformly; it is then turned carefully in the weld bath. When it is thought that the ground is ſufficiently deep, a pattern is tried in the vat, to determine whether the colour is of the proper ſhade; if it has not ground enough, decoction of weld is added; and when it is certain that the yellow has attained the proper degree, the ſilk is taken out of the bath, waſhed, and dipped in the vat as for blue.

To render the colour deeper, and at the ſame time to vary its hue, decoction of logwood, fuſtic, or annotta, are added to the yellow bath after the weld has been taken out; for the

very light ſhades, ſuch as apple and ſea-green, a much weaker ground is given than for the others. For all the light ſhades except ſea-green, it is thought beſt to give the yellow by baths which have been already uſed, but which contain no logwood or fuſtic; becauſe ſilk when completely alumed take the colour too quickly in freſh baths, and is then ſubject to be dyed unequally.

When raw ſilk is to be dyed green, that which is naturally white is choſen, as for yellow, and after being well ſoaked, is alumed and treated in the ſame way as other ſilks.

When the blue vat is employed to dye green, ſaw-wort may be employed inſtead of weld; it is even preferable, becauſe the colour it gives inclines naturally to green: dyers-broom may alſo be employed, and ſometimes theſe ſubſtances are mixed together; other ſubſtances which dye yellow may alſo be employed, and a variety of ſhades thus procured.

The green obtained by means of ſolutions of indigo in ſulphuric acid is known by the name of Saxon green; it has more brightneſs, but leſs durability, than that above deſcribed: this proceſs was firſt executed in Saxony, and government cauſed a deſcription of it to be publiſhed

published in 1750*. According to this description, the cloth must be boiled for half an hour with alum and tartar, taken out and aired without being washed; the bath is then to be cooled, and the solution of indigo well mixed with it, adding at first only one half; the cloth is then put in and turned rapidly without boiling for five or six minutes; it is then taken out that the remainder of the solution may be added, which ought to be mixed with great care: after having gently boiled the cloth in it for seven or eight minutes it is taken out and cooled; the bath is emptied to about three fourths, perhaps somewhat more or less, according to the shade of green we wish to produce; it is then filled with a decoction of fustic, and when this bath is very hot, the cloth which had been dyed blue and cooled, is dipped in it, until it has acquired the proper shade. Cloth dyed blue in the bath with alum and tartar, has a less vivid, but more durable colour, than when it is dyed blue in a bath with water, without any other addition.

Experience has taught a more expeditious and even a more certain mode of conducting this process; a boiling is given as for welding,

* Maniere de teindre un drap blanc en verd, nommé verd de Saxe.

and

and the cloth is then washed, fustic in chips enclosed in a bag, is put into the same bath, and boiled for an hour and a half, then taken out and the bath cooled to a temperature which the hand can support; nearly a pound and a quarter of the solution of indigo for each piece of cloth of eighteen ells which is to be dyed, is then added; at first it is to be turned with rapidity, and afterwards slowly; the cloth is to be taken out before the bath boils. It is a proper practice to put in only two thirds of the solution at first, to take out the cloth after two or three turns, and then to add the last third; the colour is thus rendered more uniform; if it is observed that the colour does not take well, a little calcined alum reduced to powder is added. The saxon apple green is dyed in the bath which has served for saxon green, after one third or one half of it has been taken out, and after it has been cooled; the cloth is turned in it until it is near boiling.

It is easy to perceive, that a great variety of greens may be produced, not only according to the proportions of the indigo and yellow dye employed, but according to the nature of the yellow substance, which may affect the green, both as to shade and fixity; and the colour may be still further modified by reactives.

M. Poerner

M. Poerner thus obtains a great variety of ſhades by means of a ſolution of indigo in the ſulphuric acid, to which he adds pot-aſh, and which has been deſcribed in treating of indigo. He prepares a pound of cloth, by boiling it two hours with two ounces and a half of alum, and leaves it for twenty-four hours in the bath after it has grown cold; he then boils it for an hour, in a bath made with five ounces of weld; after which he adds two ounces and two drams of the indigo dye, makes the bath boil a quarter of an hour, redips the cloth which he had taken out, and boils it again for an hour. It thereby acquires a light green colour inclining to yellow. To make the colour more of a green, M. Poerner adds to the bath either tartar, which weakens the yellow colour, or ſulphat of lime, which renders it deeper, or ſulphat of copper or verdegris; he alſo increaſes the quantity of ſolution of indigo as far as two ounces and a half; ſometimes he increaſes the quantity of the weld. By theſe means, ſeveral of which he ſometimes unites together, he obtains greens, in which the yellow or the blue are more or leſs predominant, and which are more or leſs deep. He employs the ſame proceſſes with many other yellow ingredients, ſuch as ſaw-wort, broom, fuſtic, &c.

and

and each of these substances likewise produces varieties.

According to M. Guhliche, three yellow substances may be employed for dyeing silk of a saxon green; turmeric, fustic, and french berries.

The greens obtained by means of turmeric are the most beautiful, but the most fading. The silk is alumed in the proportion of four ounces of alum to the pound, being left twelve hours in the solution when cold: a bath is prepared with an ounce of pounded turmeric, to which as much solution of indigo in sulphuric acid as will give it a sufficiently green colour is added; an ounce of solution of tin is then mixed with it, and the alumed silk dipped until it has acquired a fine green colour, when it is wrung, washed, and dried in the shade.

When french berries are used, a more beautiful colour is obtained by employing the tincture made with the aceto-citric acid, as already mentioned: as the bath is acid, only two ounces of alum are employed in aluming each pound of silk; in other respects, the process is conducted like the former. The shades may be varied by the proportions of the solutions of indigo. If the blue prevails, a sea

green

green is produced. The light ſhades may be dyed after the deep ones.

It is mentioned as a fault in the ſaxon blue, that it has a greeniſh caſt, which is probably owing to the ſlight alteration produced in the particles of indigo by the ſulphuric acid; it is alſo ſaid to be a fault in ſaxon green, that it has leſs durability than the blue and green produced by means of the vat. It has been attempted in England, to obtain the brightneſs which characterizes the ſaxon blue and green, avoiding the faults which accompany it, and uniting the advantages of the blue of the vat, and thoſe of the ſolution of indigo in the ſulphuric acid. M. Guhliche deſcribes a proceſs for giving ſilk the engliſh blue and green. I have judged it proper here to unite theſe two objects together.

M. Guhliche deſcribes a cold vat which he employs for dyeing ſilk blue, and which he highly extols for convenience and cheapneſs, as well as for the beauty of the colours it produces.

This vat is compoſed of a pound of indigo, three pounds of good quick lime, or lime ſlacked by the air, three pounds of engliſh vitriol, and a pound and a half of orpiment. The indigo ſhould firſt be carefully ground and mixed with water, put into a wooden vat and

and diluted with water to a proper degree, according to the intenſity of the colour we wiſh to obtain; the lime is then to be added, and the mixture well ſtirred, covered up, and left at reſt for ſome hours, when the vitriol reduced to powder is to be added, the whole well ſtirred, and the vat covered; ſome hours after, the orpiment in powder is to be thrown in, and the whole again left at reſt for ſome hours; after this, the mixture is to be ſtirred, and left to ſettle until the ſupernatant liquor appears clear, when the flower which covers it is put aſide; the ſilk is then dyed hank by hank, after having been previouſly dipped in warm water. When taken out of the bath, it is waſhed in a ſtream of water and dried. When the bath becomes turbid, it is left to ſettle till it grows clear, a precaution eſſentially neceſſary for the light ſhades, and when it begins to be exhauſted, one third of the ingredients are added, proceeding as at firſt. In proportion as the vat is exhauſted, the ſhades become lighter. This vat ſerves equally well for ſilk, thread, and cotton. M. Guhliche is of opinion, that thoſe who have not ſucceeded in dyeing ſilk in the cold vats, or who complain that only weak ſhades are thus obtained, have been led into an

error by having employed too ſmall a quantity of orpiment [b].

For engliſh blue, it is neceſſary firſt to give ſilk a light blue: when taken out of this bath, it is dipped in hot water, waſhed in a ſtream, and left in a bath compoſed of the ſolution of indigo in the vitriolic acid, to which a little ſolution of tin has been added, until it has acquired the proper ſhade, or has exhauſted the bath: before it is put into this bath, it may be dipped in a ſolution of alum, in which it muſt not be ſuffered to remain too long. Silk dyed in this manner has neither the reddiſh caſt given by the blue vat, nor the greeniſh caſt of the ſaxon blue.

To make engliſh green, which is more beautiful than common green, and more durable than ſaxon green, Mr. Guhliche firſt gives the ſilk a light blue in the cold vat, ſoaks it in warm water, and waſhes it in a ſtream, dips it in a weak ſolution of alum, prepares a bath with the ſolution of indigo in ſulphuric

[b] For wool Mr. Guhliche employs a vat compoſed of one pound of indigo, four pounds of pot-aſh, one pound of lime, and a pound or a pound and a half of orpiment. The proceſs is the ſame, except that he keeps this laſt vat at a moderate degree of heat. He employs it alſo in the ſame way to give engliſh blue and green to cloth.

acid,

acid, an ounce of ſolution of tin, and the tincture of french berries already deſcribed: in this bath the ſilk is kept until it has taken the deſired colour, when it is waſhed and dried in a ſhady place; the lighter ſhades may be dyed afterwards. The ſhades are rendered more or leſs blue, or more or leſs yellow, according to the proportions of the yellow ſubſtances and ſolution of indigo. When a goſling green (verd d'oie) is to be given to ſilk, it is firſt dyed of a light blue, either in the hot or cold vat, then paſſed through hot water, and waſhed in a ſtream, and while ſtill moiſt, dipped in an annotta bath.

To give a green colour to linen and cotton thread, they are firſt ſcoured, dyed in the blue vat, cleanſed and dipped in the weld bath. The ſtrength of blue and the yellow is proportioned to the colour we wiſh to obtain. As it is difficult to dye cotton velvet uniformly in the common blue vat, it is firſt dyed yellow with turmeric, and finiſhed green with the ſolution of indigo in the ſulphuric acid. It is a matter of indifference whether we begin with the yellow or the blue.

Mr. Pileur d'Apligny deſcribes a proceſs for dyeing cotton velvet, or ſkeins of cotton, of a ſea or apple green in a ſingle bath.

Verdegris

Verdegris is mixed with vinegar, and the mixture kept well ſtopped fifteen days in a ſtove; four hours before uſing it, a ſolution of a quantity of cendrés gravelées equal in weight to that of the verdegris is added, and the mixture is kept hot. The cotton, thread, or velvet are prepared, by being ſoaked in a warm ſolution of alum, made in the proportion of one ounce of ſalt, and five quarts of water to the pound, they are then taken out, and the verdegris mixture added to the bath, into which they are returned in order to be dyed.

All the ſhades of olive, and drake's-neck green, are made by giving the thread a blue ground, galling it, and dipping it in a weaker or ſtronger bath from the black caſk, then in the weld bath with the verdegris, and afterwards in the bath with the ſulphat of copper; and laſtly, the colour is brightened with ſoap.

A green colour may alſo be given to cotton which has been dyed blue with pruſſian blue, by the proceſs deſcribed, Sect. II. Chap. V. of the ſecond part; the piece while ſtill wet with the blue, is alumed[c] and dipped in a weld bath, which is ſtronger or weaker according to

[c] L'art du fabricant de velours de coton.

the ſhade required. Weld produces a more lively colour than fuſtic, which gives a deeper ſhade and diminiſhes the brightneſs of the blue; if a green inclining to olive be required, fuſtic is preferable. It is dried in the open air as for blue.

There is nothing obſcure in the formation of the green, produced by giving a yellow colour to a ſtuff previouſly dyed blue and waſhed. The colour inclines more or leſs to yellow or to blue, according to the depth of the blue ſhade, and the ſtrength of the yellow bath. The intenſity of the yellow is increaſed by alkalis, ſulphat of lime, and ammoniacal ſalts; it is diminiſhed by acids, alum, and ſolutions of tin. The ſhades alſo vary according to the nature of the yellow ſubſtance employed.

Different effects will be produced by the ſame ingredients in the formation of ſaxon green, according to the proceſs which is employed: if a ſaxon blue be firſt given, and afterwards the yellow colour, ſeparately, the effects will be ſimilar to thoſe juſt mentioned; but if the ſolution of indigo be mixed with the yellow ingredients, other reſults are obtained, for then, the ſulphuric acid acts on the

the colouring particles and diminiſhes the intenſity of the yellow.

When a ſucceſſion of ſhades are dyed in a bath compoſed of yellow and the ſolution of indigo, the laſt approach more and more to yellow, becauſe the particles of indigo become attached to the ſtuff in preference to the yellow ones, which are therefore rendered predominant in the bath.

Although ſulphat of copper and even verdegris, which is ſometimes employed, chiefly to dye thread and cotton, have a blue colour, yet they give the ſtuff a greeniſh colour, becauſe the oxyd of copper which is attached to it, acquires that colour by combining with a larger quantity of oxygen; for it has been ſhewn in the firſt part, that the colour of this oxyd changes from blue to green, according to its quantity of oxygen. This colour is made to incline to an olive hue by means of a yellow ſubſtance.

CHAP. II.

Of the Mixture of Red and Blue.

BY the mixture of red and blue, we obtain violet, purple, dove colour, panſey, amaranth, lilac, mauve, and a great number of other ſhades, determined by the nature of the ſubſtances, the red colour of which is combined with the blue, by the proportion of theſe ſubſtances, and the different ſteps of the proceſs.

According to Hellot's obſervations, ſtuff which has been dyed ſcarlet, takes an unequal colour when blue is to be united with it. The blue is therefore given firſt, which, even for violet and purple, ought not to be deeper than the ſhade diſtinguiſhed by the name of ſky-blue, a boiling is given with alum mixed with two fifths of tartar, the ſtuff is then dipped in a bath compoſed of nearly two thirds as much cochineal as for ſcarlet, to which tartar is always added. The circumſtance which diſtinguiſhes the proceſs for purple from that for violet, is, that for the former, a lighter

lighter blue ground is given, and a larger proportion of cochineal is employed. These colours are frequently dyed after the reddening for scarlet, such quantities of cochineal and tartar being added as are thought necessary. The operation is conducted in the same manner as for scarlet.

Lilacs, pigeons necks, mauves, &c. are commonly dipped in the boiling which has served for violet, after alum and tartar have been added to it: the blue ground having been proportioned to the shade required, the quantity of cochineal is also adjusted in a similar manner: a little solution of tin is added for some reddish shades, such as peach blossom. It must be observed, that though the quantity of cochineal is diminished according to the lightness of the shade required, the quantity of tartar is not lessened, so that the proportion of it compared with that of the cochineal, is so much the greater, as the colour required is lighter.

Mr. Poerner is of opinion, that to obtain the colours composed of red and blue, it is advantageous to employ the solution of indigo in sulphuric acid, because a great variety of shades is thus more easily procured, and the process is shorter and less expensive. The

colours obtained in this way are indeed much lefs durable than when the blue vat is employed; but Mr. Poerner afferts, that they poffefs durability, when folution of indigo to which alkali has been added is employed.

He prepares a pound of cloth with three ounces of alum, by boiling it for an hour and a half, and leaving it a night in the liquor after it is cold. He makes the bath with an ounce and a half of cochineal, and two ounces of tartar, boiling it for three quarters of an hour, and then adding two ounces and a half of folution of indigo, he ftirs it, and makes it boil gently for a quarter of an hour: he thus obtains a very beautiful violet.

For the different fhades which refult from the mixture of red and blue, according as one or other of the colours prevails, he increafes or diminifhes the proportion of the folution of indigo; he increafes it as far as five ounces, and diminifhes it to five drams for each pound of cloth: he alfo reduces the quantity of cochineal, but never below an ounce, becaufe the colour would become too dull: he changes the proportion of tartar, and finally, he varies the preparation given to the cloth, by the addition

addition of tartar or ſolution of tin in different quantities.

In ſilk, two kinds of violets are diſtinguiſhed, the fine and the falſe: the laſt is made either with archil or braſil-wood.

For the fine violet, the ſtuff is firſt paſſed through cochineal, and afterwards dipped in the vat; the ſilk is prepared and dyed in the cochineal in the ſame manner as for crimſon, except that neither tartar nor ſolution of tin, which ſerve to heighten the colour, are employed. More or leſs cochineal is uſed, according to the intenſity of the ſhade required. The common proportion for a fine violet, is two ounces for each pound of ſilk. When the ſilk is dyed, it is waſhed at the river and beetled twice, then dipped in a vat of greater or leſs ſtrength, according to the depth we wiſh to give the violet; finally, it is waſhed and dried with the precautions which are proper for all colours dyed in the vat. To give greater ſtrength and beauty to the violet, it is commonly paſſed through the archil bath; and this cuſtom, which is frequently abuſed, is indiſpenſable for the light ſhades, the colour of which would otherwiſe be too dull.

When the ſilk has been dyed with cochineal as above directed, a very light blue ſhade muſt be given it for purple: only the deepeſt ſhades are dipped in a weak vat; ſuch as are leſs deep are only dipped in cold water, into which a little of the liquor of the vat has been put, becauſe they would take too much blue in the vat itſelf, though ever ſo weak. The light ſhades of this colour, ſuch as gilly-flower, gridelin, and peach bloſſom, are made in this way, by diminiſhing the proportion of cochineal.

The falſe violets in ſilk are produced in many different ways; thoſe which are moſt beautiful and moſt in uſe, are prepared with archil. The ſtrength of the archil bath is adapted to the colour we wiſh to obtain; the ſilk is turned in it on the ſkein ſticks, after having been beetled at the river after ſcouring: when the colour is thought to be ſufficiently deep, a pattern is tried in the vat, to ſee whether it takes the violet we wiſh for. If the ſhade is found to be of the proper depth, the ſilk is beetled at the river and dipped in the vat as for the fine violets; leſs of the blue, or leſs of the archil colour are given, according as we mean that the violet ſhould incline to red or blue.

According to Mr. Guhliche, beautiful violets may be produced in ſilk by means of the ſolution of indigo; but they poſſeſs little durability and become reddiſh, becauſe the colour of the indigo fades firſt.

A pound of ſilk is ſoaked in a bath compoſed of two ounces of alum and two ounces of ſolution of tin, after being decanted from the ſediment formed in the mixture. The dye bath is prepared with two ounces of cochineal (reduced to powder with a dram of tartar) and the remainder of the bath which has ſerved as mordant, with the addition of a ſufficient quantity of water; after being ſlightly boiled, ſuch a quantity of ſolution of indigo is added, as gives the bath a proper ſhade of violet; the ſilk is then immerſed, and boiled until it has acquired the proper ſhade, when it is wrung, waſhed in a ſtream, and dried in the ſhade, like all delicate colours. The bath is exhauſted by the light ſhades.

A violet is given to ſilk, by dipping it in water with which verdegris has been mixed, inſtead of aluming it; and then giving it a bath of logwood, where it aſſumes a blue colour, which is changed to violet, either by adding alum to the bath, or by dipping it in a weaker or ſtronger ſolution of alum, which gives

gives the particles of logwood a red colour. It is unneceſſary to obſerve, that this violet is of a very fading nature, and only a moderate degree of beauty; one poſſeſſing much greater beauty, and to which a conſiderable degree of intenſity may be communicated, is made by dipping the alumed ſilk in a bath of braſil-wood, and again, after it has been waſhed at the river, in a bath of archil. Madder is alſo employed in dyeing cloth, after it has had a blue ground; couleur de roi, minime, and obſcure amaranth, are thus obtained; galls are commonly added to the madder, and for the light ſhades, braſil-wood; for the deep ſhades, more or leſs browning is given, with a ſolution of ſulphat of iron. Theſe colours are rendered more beautiful by the addition of kermes, or more eſpecially of cochineal.

By employing ſolution of indigo with madder, in the ſame way as with cochineal, we may, according to Mr. Poerner, obtain brown colours inclining the more to red, the leſs ſolution of indigo we employ; alum and tartar may ſerve for the preparation, but alum muſt not be put into the bath.

Mr. Poerner employs braſil-wood and ſolution of indigo, to obtain different colours, which incline more or leſs to blue and red,

by

by a procefs fimilar to that pointed out for cochineal and madder. Thefe are beautiful, but durability cannot be expected in colours obtained by fuch means. The fubftances which render them moft fixed, are fulphat of lime, fulphat of zinc, or white vitriol, and acetite of copper, or cryftallized verdegris, which muft be added to the bath.

Logwood is alfo employed to make floe, damafcene, purple, and other fhades. This wood with the addition of galls, very eafily communicates all thefe colours to wool previoufly dyed blue. When we wifh to brown them, a little fulphat of iron is employed, and by thefe means we produce fhades, which are much more difficultly obtained from durable ingredients, but they poffefs little ftability: durable colours which have been highly efteemed, have however been obtained from brafil and logwood. I am indebted to Mr. Decroizille, who is occupied in the arts with all the knowledge of a well-informed chemift, for the following particulars of the procefs employed, of which the defcriptions given have been inaccurate.

" Mr. Giros de Gentilly is the firft who
" fucceeded in France, in obtaining a durable
" dye from violet wood fixed by folution of
" tin.

"tin. His firſt eſſays were made at Louviers, "with Meſſrs. Petou, Nephew, and Frigard, "about twelve years ago. From what he "had ſuffered to tranſpire reſpecting the ſub- "ſtances which compoſed his mordant, I "ſucceeded in imitating him tolerably well. "I made a ſolution of tin in ſulphuric acid, "to which I then added muriat of ſoda, red "acidulous tartrite of pot-aſh, and ſulphat "of copper. My ſucceſs was ſo great as to "induce Mr. Giros to offer me a partnerſhip "in the very lucrative trade in this article, "which he carried on at Louviers, Elboeuf, "Abbeville, Sedan, and the Pays de Liege. "Mr. Giros then taught me a much more "convenient mode of forming this compound; "it conſiſts in making a ſolution of tin in a "mixture of ſulphuric acid, muriat of ſoda, "and water; to this ſolution, the tartrite and "ſulphat are added, in the form of powder. "Of this mordant we made no leſs than "fifteen hundred quarts in twenty-four hours, "in a ſingle leaden veſſel moderately heated. "We carried on a very profitable trade in "this article at the rate of thirty ſols (fifteen- "pence Eng.) per pound for three years, ſince "which time it conſtantly declined, until we "loſt it altogether; the reaſon of which was "this:

" this: Mr. Giros having ſuffered his ſecret " to tranſpire, we had a number of imitators, " who at firſt ſucceeded in a leſs degree, but " afterwards better than ourſelves. In a com- " pound conſiſting of ſo many ingredients as " this, in an operation which is ſtill ſo obſcure " as that whereby colours are fixed, it is almoſt " impoſſible to arrive at perfection, by any " other means than random trials, which may " be infinitely varied by the different propor- " tions, and more eſpecially by the modus " agendi, and to a much greater extent, than " chemiſts who had beſtowed leſs time on this " ſubject than I have done, would ſuppoſe. " I am therefore not aſhamed to confeſs that " I was forced to abandon the buſineſs, while " I ſaw, and ſtill ſee, thoſe who are no che- " miſts deriving a very comfortable profit from " it. What determined me to abandon it " altogether, was the invention of the new " proceſs for bleaching linen, to the improve- " ment of which I have almoſt entirely de- " voted myſelf.

" Having given you the hiſtory of the " mordant for the prune de Monſieur, I ſhall " mention the mode of employing it and its " effects.

" If it is wool in the fleece which is to be " dyed, one third of its weight of mordant is " required; if it is a ſtuff, only one fifth is " neceſſary. A bath is prepared of a degree " of heat which the hand can bear, with " which the mordant is well mixed, and the " wool or ſtuff dipped in it and properly " ſtirred, the ſame degree of heat being kept " up for two hours, and even increaſed a little " at laſt; it is then taken out, aired, and " very well waſhed: a freſh bath of pure " water at the ſame heat is prepared, a ſuffi- " cient quantity of the decoction of violet " wood is added; the ſtuff immerſed, ſtirred, " and the fire increaſed to a boiling heat, " which is continued for a quarter of an hour: " the ſtuff being then taken out, aired, and " carefully rinſed, the dyeing is finiſhed. If " the decoction of one pound of violet wood " of Campeachy, has been employed for three " pounds of wool, and a proportionate quan- " tity for ſtuffs, which require leſs, a fine " violet is produced, to which a ſufficient " quantity of braſil-wood gives the ſhade com- " monly known by the name of *prune de* " *Monſieur*.

" The colouring ſubſtances which are capa- " ble of being advantageouſly fixed on wool

" by

" by this mordant, are those of violet and red " wood (logwood and brasil), and fustic (bois " de fustet). Bois jaune (morus tinctoria) *, " also affords tolerable colours. The colour " which is thus given by violet and red wood " is liable to be changed in the fulling, by " means of the soap or the urine employed, " and this change, which is always produced by " alkaline substances, is remedied by a bath " very slightly acid and a little hot, called " *brightening*, for which the sulphuric acid is " prefered. The colour comes out as deep " and often brighter than before the change. " Wools dyed by means of this mordant, admit " of being spun into a more beautiful and " finer thread, than when alum has been em- " ployed. By leaving out the sulphat of " copper, more beautiful colours are obtained " from fustic and yellow wood, as well as " from weld. Madder gives an orange red " colour, but less deep than with an equal " quantity of alum; the omission of the sul- " phat of copper renders the wool much more " harsh, and besides, the mordant thus prepa- " red gives but indifferent colours with violet " and more especially with red wood. One

* Vid. notes to pages 268 and 281.

" of

" of the great defects of this mordant before " it was improved, was, and frequently ftill is, " to render the colours uneven; whenever " they are uniform, they turn out always very " beautiful, harmlefs, and foft. This procefs " fucceeds equally well on filk. By fubfti- " tuting acetite of lead for fulphat of copper, " it fucceeds tolerably well in cotton and " thread previoufly galled; the employment " and carriage of this mordant are inconve- " nient, on account of the heavy fediment " which half fills the veffel under a corrofive " liquor which can only be kept in ftone ware. " I have however, found a remedy for thefe " inconveniences, by omitting the water in " the receipt; by which means I have only a " kind of pafte, the ufe of which is more con- " venient, and the carriage two fifths cheaper. " Now that muriat of foda is cheap, I may " poffibly return to the employment of fur- " nifhing our dyers with this mordant, of a " better quality, in my opinion, than that " with which they are fupplied, and more " efpecially, at a much cheaper rate; but " I muft firft devote fome more time to the " compofition and employment of your lix- " ivium."

The moſt common method of dyeing thread and cotton, violet, is firſt to give them a blue ground in the vat, proportionate to the ſhade we want, and to dry them; they are then galled, in the proportion of three ounces of galls to a pound: they are left for twelve or fifteen hours in this gall bath, after which, they are wrung and dried again. The thread and cotton are then paſſed through a decoction of logwood, and when well ſoaked are taken out, and two drams of alum, and one dram of diſſolved verdegris for each pound of thread and cotton, are added to the bath; the ſkeins are then redipped on the ſkein ſticks, and turned for a full quarter of an hour, when they are taken out to be aired; after which they are again completely immerſed in the bath for a quarter of an hour, then taken out and wrung. Laſtly, the vat which has been employed is emptied; half of the decoction of logwood which had been reſerved is poured in, two drams of alum are added, and the thread dipped afreſh, until it is brought to the ſhade required. The decoction of logwood ought to be ſtronger or weaker according to the ſhade we want: this violet ſtands the action of the air tolerably well,

but cannot be compared in durability to that obtained by means of madder, which will be described in the fourth chapter of this section.

In the production of violet by cochineal, it may be observed, that the woollen stuff has been disposed to take a crimson, by the bath, which contains alum; but the tartar added to the dye bath, brings the colour back to red; this is a general property of all acids.

For purple, the red is rendered a little more predominant, by increasing the quantity of the cochineal, and diminishing the intensity of the blue ground.

The shades bordering on these two colours should have a more distinct red, and the same proportion of tartar is preserved, though that of cochineal and the depth of the blue ground are diminished.

For silk, the tartar is omitted; it naturally acquires from cochineal a colour, to which it is only necessary to add a slight blue shade to produce purple; a deeper blue shade gives a violet colour, but to increase the fulness of the violet and give it brightness, archil must be employed.

When

When ſolution of indigo in ſulphuric acid is uſed, the ſulphuric acid acts in different ways on the red ſubſtance employed; it produces little change in the colour of cochineal, already diſpoſed to a crimſon tinge by the aluming; but it ſhould give a fawn colour to madder, upon which acids readily produce this effect, and it does not ſeem probable, that that ſubſtance could be employed with advantage in this proceſs; it is better to employ it in dyeing ſtuff, which has already received a blue ground. Braſil and logwood too ſeem ill adapted to produce fine colours with the ſulphuric ſolution of indigo, becauſe acids alſo change them yellow, though in a leſs diſtinct degree; but they retain their red colour, as already obſerved, when their colouring particles are precipitated by oxyd of tin.

Were it allowable to hazard an opinion, without being guided by any direct experiments, on ſo complicated a proceſs as that communicated by Mr. Decroizille, I ſhould endeavour to explain it in the following manner.

The ſea ſalt is decompoſed by the ſulphuric acid, and the muriatic acid thus ſet at liberty,

diſſolves the tin; a part of the tin is precipitated by the acid of tartar, producing the ſediment which has been noticed. The oxyd of copper forms the blue with the colouring particles of the logwood; the oxyd of tin produces violet with the ſame wood, and red, with the colouring particles of the braſil-wood.

As the liquor retains an exceſs of acid, it might perhaps be uſeful to ſubſtitute acetite to ſulphat of copper, becauſe then, the free acid would have leſs activity; perhaps it might be ſtill better to employ verdegris, becauſe that part of the oxyd of copper which is uncombined in it, would unite with the exceſs of acid, by which means, leſs acid would remain in the liquor; perhaps the quantity of tartar ſhould be diminiſhed, becauſe leſs of the tin would then be precipitated.

CHAP.

CHAP. III.

Of the Mixture of Red and Yellow.

WHEN treating of cochineal I thought it would be improper to ſeparate operations which commonly ſucceed each other in the dye-houſe, and have therefore deſcribed the principal ſhades obtained by the mixture of the red of cochineal with yellow. Theſe ſhades may be infinitely varied by the different proportions of the ingredients, by the yellow ſubſtances made choice of, by the preparations given to the cloth, and by the mordants added to the dye bath. Thus, Mr. Poerner deſcribes a great many varieties, which he obtained by uſing weld, ſaw-wort, dyers-weed, and other yellows, and by employing in the preparation of the cloth, or in the bath, tartar, alum, ſulphat of zinc, or ſulphat of copper.

In like manner, various colours may be obtained from madder united with yellow ſubſtances. It is in this way, that mor-doré and cinnamon colours are produced; theſe colours are commonly made in two baths. We begin

by the maddering, preceded by a boiling with alum and tartar, as for the common maddering, and then give a weld bath.

For cinnamon colours, the maddering is weaker, and a bath which has ſerved for mordoré is commonly employed. The proportions are varied, according as we wiſh that the red or yellow ſhould prevail; ſometimes galls are added, and ſometimes the colour is darkened by a browning.

Mr. Poerner obtains many colours from madder mixed with ſaw-wort; he prepares the cloth with different mordants, but more eſpecially with alum and tartar; he alſo adds alum and tartar to the bath. When the quantity of either of theſe ſalts is conſiderable, the colour has an orange caſt, becauſe acids give the colour of madder a yellow hue; but if their quantity be but ſmall, a reddiſh yellow is obtained. Mr. Poerner has procured reddiſh brown colours, by putting ſulphat of zinc or white vitriol into the dye.

Sometimes it is only intended to give a reddiſh hue to yellow; in that caſe the ſtuff immediately after being dyed yellow, may be paſſed through a madder bath of different degrees of ſtrength according to the end propoſed.

Braſil-

Brasil-wood is also employed with yellow substances, and sometimes it is mixed with cochineal and madder.

When instead of weld or other yellow substances, walnut-tree root, walnut-peels or sumach are employed, snuff, chesnut, musk colours, &c. are obtained.

Marrones, cinnamons, and all the intermediate shades are given to silk, by logwood, brasil, and fustic.

The silk is scoured as usual, alumed, and a bath prepared, by mixing decoctions of the three above-mentioned woods made separately; the proportion of each is varied according to the shade required, but that of the fustic ought to prevail; this bath should be of a moderate temperature. The silk is turned on the skein sticks in the bath, and when it is taken out, if the colour be uniform, it is wrung and dipped in a second bath of the three ingredients, the proportions of which are regulated according to the effect of the first bath, in order that the proper shade may be produced.

Cinnamon and mor-doré colours are given to thread and cotton, by beginning the process for dyeing them with verdegris and weld; they are then dipped in a solution of sulphat of iron, called *bain d'assurage*, wrung and dried. When dry,

they are galled in the proportion of three ounces of galls to the pound, dried again, alumed as for red, and maddered. When dyed and washed they are put into very warm soap suds, and turned until they are sufficiently brightened; decoction of fustic is sometimes added in the aluming.

The mixture of red and yellow affords no particular observations, in addition to those contained in the two last chapters.

For some colours, blue is united to red and yellow; it is thus that olives are made. A blue ground is first given, then the yellow dye, and lastly, a slight maddering. The shade which results from this operation depends on the proportion of the three colours of which it is composed; for the deep shades, a browning is given with a solution of sulphat of iron.

Mr. Poerner combines blue with yellow and red, by employing the solution of indigo in the sulphuric acid, to which he adds alkali, as already mentioned. He prepares a bath with cochineal and fustic, adds the solution of indigo, and dyes the cloth in it after it has been alumed. He also makes a bath with fustic and brasil-wood, to which he adds tartar or alum, and thus obtains different colours inclining more or less to blue, red, or green.

The

The blue vat is not employed to produce olives in ſilk, which, after the aluming, is dipped in a very ſtrong weld bath; to this, juice of logwood is afterwards added, and when the ſilk is dipped, a little ſolution of alkali is put in, which turns it green, and makes the ſilk take an olive colour. The ſilk is dipped in this bath afreſh, until it has acquired the proper ſhade. For the colour which is called *olive rouſſe*, or rotten olive, fuſtic and logwood, but no alkali are added to the bath after the welding: if it is intended, that the colour ſhould have more of a red caſt, only logwood is added. A kind of reddiſh olive is alſo made, by dyeing the ſilk in a bath of fuſtic, to which more or leſs ſulphat of iron and logwood have been added.

According to M. le Pileur d' Apligny, a fine olive is given to thread and cotton, by boiling four parts of weld and one of pot-aſh in a ſufficient quantity of water; braſil-wood which has been ſteeped over night, is boiled ſeparately with a little verdegris; theſe two ſolutions are mixed in different proportions according to the ſhade required, and the cotton or thread are dipped in them.

CHAP.

CHAP. IV.

Of Shades which result from the Mixture of Black with other Colours, and of Brownings.

I HAVE defcribed the proceffes whereby we obtain black, which conftitute the different fhades of gray; I have fhewn, that other fhades of a different kind might be mixed with them, fo as to make them incline towards certain colours; but black is often mixed with other colours which are to remain predominant: it is only wifhed that they fhould be browned, and at the fame time acquire greater durability. In the courfe of this work I have fometimes mentioned that a browning was given to certain colours; but in the prefent chapter I fhall treat particularly of this operation, and of the refources which it affords to the art, fometimes for the purpofe of imitating colours which may be obtained by other means, fometimes for the production of new colours.

To give a browning, ftuff which has been juft dyed, is dipped in a folution of fulphat

of iron to which an aſtringent has been added, and which conſequently forms a *black bath;* more frequently, a ſmall quantity of ſolution of iron is mixed with a bath of water, and more is added, till the dyed ſtuff dipped in it, has attained the ſhade required: more rarely, ſulphat of iron is added to the dye bath, but the deſired effect is obtained with greater preciſion, by dipping the dyed ſtuff in a ſolution of ſulphat of iron. Mr. Poerner frequently ſoaks the ſtuff in a ſolution of ſulphat of iron, to which he ſometimes adds other ingredients, and when taken out of this mordant, he dips it in the dye bath.

The firſt method is employed for marrones, coffee, damaſcene colours, and other ſhades of browns of the common dye; a more or leſs deep colour is given them, according to the ſhade we wiſh to obtain by the browning; a bath is then made with galls, ſumach, and alder bark, with the addition of ſulphat of iron. The ſtuffs intended for the lighteſt ſhades are dipped firſt; and when they are finiſhed, the browner ones are dipped, a quantity of ſulphat of iron proportionate to the end propoſed, being added for each operation.

The other brownings have nothing peculiar in the proceſs: I ſhall ſelect ſome examples of

of the effects produced, and point out some particular processes.

We have seen in the first section of this second part, that for several kinds of gray, a slight blue ground was given. Mr. Poerner makes blueish grays, by employing the solution of indigo in sulphuric acid, which he adds to a mixture of decoction of galls and sulphat of iron, varying the shades by the different proportions of these three ingredients; he obtains other shades, by adding sulphat of iron to a bath composed of cochineal, fustic, and galls.

For couleur de roi, a sky blue ground is given with pastel, the dye is given with weld and one sixth of galls, and the browning, with solution of sulphat of iron.

Marrone, and the colours which border upon it, are made with saunders, galls, and a browning, and sometimes logwood is added: these colours are sometimes made to incline towards purple and crimson, by dyeing them in the remains of a cochineal bath, or by putting a little madder or cochineal into the bath; the colour is rendered lighter by a little tartar.

For hazel colours, galls, fustic, and logwood are mixed, and more or less madder, and a little alum are added.

M. Guhliche

M. Guhliche employs cochineal and the ſolution of iron already deſcribed *, to produce a violet

* A deſcription of the ſolution of iron employed by M. Guhliche, has been given at page 24 of this part; it is a black dye bath, for a black colour may be obtained from it, without the uſe of other ingredients. M. Guhliche, in the fourth volume of his work, deſcribes the manner in which he employs this ſolution, in order to produce blacks and grays, in wool and ſilk. He ſoaks the wool in a ſolution of iron, either hot or cold, and then dips it in a bath compoſed of ſolution of galls in white wine, and of ſumach; he ſometimes employs logwood alone, or mixed with a ſolution of galls and ſumach, and ſometimes with a little madder; he ſometimes begins by ſoaking it in the ſolution of iron, and afterwards dipping it in the aſtringent bath: he alſo employs his ſolution alone; but then he does not mix that which is made with rice, with that made with vinegar, and he paſſes the wool from one ſolution to the other, either ſteeping it in the cold, or boiling and drying it between the two immerſions: if he does not find the black ſufficiently deep, he adds a little ſolution of galls to the two baths.

He impregnates ſilk with a ſolution of galls in white wine more or leſs diluted with water; in this, it is left to ſoak for twelve hours, then dried, and put into the ſolution of iron in the cold, where it is ſuffered to remain till it has acquired a proper black; he ſometimes mixes logwood juice with the ſolution of iron, and keeps the galled ſilk in it, making it boil a little towards the end. He alſo makes uſe of the ſolutions of iron in the rice water and vinegar, without mixing them; he begins by macerating his ſilk in the firſt, cold, then dries and ſoaks it in the ſecond: theſe immerſions he repeats, if the firſt operation has not given a ſufficiently

a violet which indeed inclines to brown but poſſeſſes great durability. He alums a pound of woollen ſtuff in a ſolution of two ounces of alum; he makes a bath with an ounce of cochineal, and adds an equal quantity of ſolution of iron, in which he keeps the ſtuff, until it has acquired a proper ſhade. Lilacs may be dyed with the remainder. If a colour with leſs of a brown caſt be required, a ſmall quantity of ſolution of iron is employed, and an ounce of nitre is added.

Braſil-wood, the colour of which has been extracted by means of the aceto-citric or nitro-muriatic acid, may be employed in the ſame manner.

To obtain puce colour from madder, M. Guhliche gives a pound of woollen ſtuff a boiling, compoſed of two ounces of alum, a certain quantity of vinegar and ſolution of iron, and after a quarter of an hour's ebullition, he leaves it twelve hours in the mordant; he makes a bath with the decoction of two ounces of white galls poured off clear from the ſediment, with which four ounces of good madder

a ſufficiently deep black: the remains of all theſe baths are employed for the lighter ſhades, either ſeparately or mixed together.

are mixed, and when it begins to grow hot, he dips the ſtuff, when taken out of the mordant, and ſuffers it to remain there, gradually increaſing the heat, until it has taken the deſired colour; it is then boiled for two minutes, waſhed and dried in the ſun. The colour obtained by this proceſs is very durable. If the alum and vinegar of the mordant be omitted, a deeper brown is obtained: after theſe colours the lighter ſhades are dyed. Sumach may alſo be ſubſtituted for one half of the madder.

Braſil and logwood employed in equal quantities, or in other proportions, give different brown colours of tolerable durability, when, more or leſs ſolution of iron is mixed with a decoction of them, and the wool previouſly alumed and galled, is dyed in it; theſe colours however cannot vie with the former, in durability.

Different ſhades of mor-doré and capucine may be given to the above colours, by dipping them in a bath of annotta as ſoon as they are taken out of the dye.

M. Guhliche gives ſilk a purple violet, without a blue ground; for this purpoſe, he mixes one part of ſolution of galls in white wine, with three parts of water, in which he macerates a pound of ſilk for twelve hours, ſoaks

it

it in a mordant, composed of two ounces of alum, one ounce of solution of tin, and half an ounce of muriatic acid; after it has been wrung, he dyes it in a bath prepared with two ounces of cochineal and a little solution of iron, until it has taken the desired shade: for dyeing lighter shades, the residua of these baths may be used, either separately or mixed together.

He employs madder in the same way, macerating for twelve hours a pound of silk in a solution of two ounces of alum mixed with an ounce of muriatic acid, and a certain quantity of solution of iron; when wrung, he dyes it in a bath prepared with eight ounces of madder. If he wishes to obtain deeper colours, he adds to the madder and cochineal baths some of the solution of galls in white wine.

He also dyes silk, soaked in a solution of two ounces of alum and an ounce of muriatic acid, in a bath composed of equal parts of brasil and logwood juice, with the addition of a certain quantity of solution of iron; and to render the colour deeper, he adds solution of galls.

To make these colours incline to mor-doré and capucine, he sometimes adds solution of tin to the above baths.

He makes brick colours, by dipping the silk, prepared with solution of galls mixed with a certain quantity of solution of iron, in an annotta bath.

A great variety of shades are obtained by the mixture of brasil, logwood, archil, and galls, and by a browning with sulphat of iron; but all these shades are more or less disposed to fade, though they have an engaging brightness.

The black bath distinguished by the name of black cask, *(tonneau noir)* is employed to give thread and cotton a great number of dark colours, of which I shall now mention a few instances.

To give a durable violet to thread and cotton, they are scoured in the usual way; a mordant is prepared, composed of two quarts of the bath of the black cask, and four quarts of water per pound; this is made to boil, and the scum which forms on its surface is removed; when no more appears, the liquor is poured into a vat, and when it is just warm, four ounces of sulphat of copper and an ounce of salt petre are dissolved in it; the skeins are then left in it to soak for ten or twelve hours, wrung and dried. When they are to be maddered, they are carefully washed and dipped in a madder bath. If a deep violet is required, two ounces of verdegris are added to the bath; the colour

is rendered ſtill deeper by galling the thread more or leſs, before it is put into the mordant, and by omitting the ſalt petre; if the proportion of this laſt be increaſed, and that of the ſulphat of copper be diminiſhed, the violet inclines more to lilac. The mordants may alſo be modified in different ways, ſo as to produce a great number of ſhades.

For the different ſhades of marrone, cotton is galled, dipped and worked in the uſual manner, in a bath, to which more or leſs of the liquor of the black caſk has been added; it is then waſhed in a bath, with which verdegris has been mixed, welded, and dyed in a bath of fuſtic, to which ſolution of ſoda and alum are ſometimes added. After the cotton thus prepared has been completely waſhed, it is well maddered, then dipped in a weak ſolution of ſulphat of copper, and laſtly, in ſoap ſuds.

The proceſſes by which dark colours are given to printed linens are very ſimple; the parts which have been impregnated with a ſolution of iron, acquire in the maddering, a violet colour approaching more or leſs to black; thoſe which have been impregnated with the ſolution of iron and the acetite of alumine, take brown and puce colours.

When

When a ſtuff which has received a colour, is dipped in a black bath more or leſs diluted, the effect produced is ſimple; it is a ſhade of black more or leſs deep, which is united to the firſt colour.

This is not the caſe when the coloured ſtuff is dipped in a ſolution of iron; for then, the colouring particles which were attached to the ſtuff, act upon the ſulphat of iron, take up a part of its oxyd, and combine with it and the ſtuff: the colour which reſults from this union is more or leſs deep, not according to the colour which is proper to the colouring particles, but chiefly, according to the action which they exert on the metallic oxyd, agreeably to the principles laid down in the firſt part; thus the braſil and logwood which enter into the compoſition of a colour, will produce a much more remarkable effect in the browning, than madder or cochineal; galls and ſumach will produce a ſtill more conſiderable one, though they only affected the original colour by the production of a fawn-coloured ſhade.

If a black bath be prepared, or a black dye produced, either in the mordant, or in the dye bath, the ingredients which are mixed with the colouring ſubſtances will influence the reſult

of the operation by the action they exert on the black particles; thus, alum, solution of tin, and solution of indigo, will weaken the effect which the black particles would have produced: all the acids will act in the same manner, except the acetous, and perhaps some other vegetable acids which have not the property of dissolving the black particles: it would seem that nitre is capable of dissolving them, as it renders the colours in which it is employed, lighter.

As the best colours which can be given to thread and cotton are obtained from madder, the different means mentioned in treating of madder, for rendering this dye more durable must be attended to, and the colour may be rendered darker by different black baths.

For some hazels and snuff colours, a browning with soot is given, after the welding and madder bath, to which galls and fustic have been added; soot is sometimes mixed with this bath, and a browning is also given with a solution of sulphat of iron; walnut-peels are sometimes substituted for solutions of iron in browning colours. They have a great advantage for tho wools intended for tapestry, for the colour does not grow yellow by long exposure to the air, as happens in the browning produced by iron, but

but remains a very long time without change; it has indeed a dull hue, which is proper for ſhades, and to repreſent the colour of the fleſh if old figures, but which would produce only dull and heavy colours in ſtuffs; the goodneſs and cheapneſs of this colour however, ought to render its uſe more extenſive for grave colours, which are ſometimes faſhionable, at leaſt in common ſtuffs.

An infinity of ſhades are made by this browning at the Gobelins: to produce an aſſortment of theſe, a boiling with tartar and alum of different degrees of ſtrength according to the ſhades required, is given to the woollen yarn, which is then ſucceſſively dyed red, yellow, or ſome other colour, recurring to the bath from which we wiſh to obtain a greater effect. When the colour is found to be of the proper ſhade, it is left for a longer or ſhorter time, in a bath of walnut-peels of a degree of ſtrength adjuſted to the end propoſed. This browning is alſo employed for ſilk, but then, the bath muſt be ſcarcely warm, that the inequalities to which it is very liable may be avoided.

DESCRIPTION

OF THE

TRANSLATOR'S APPARATUS

For the Diſtillation of ACIDS and other SUBSTANCES.

The Plate being upon the Scale of about an Inch to a Foot.

A IS the retort, the neck of which is ground into and paſſed through the thick ſtopper B, repreſented below ſeparately at b, with its ground ſtopper a, which may be put in when the neck of the retort is withdrawn. The external part of the ſtopper B is accurately ground into the wide neck of the receiver C, the narrow neck of which is ground into the wide neck of the receiver D, the narrow neck of which is ground into that of the receiver E; in the receiver D there is alſo another aperture in its ſuperior part, into which the tube H open at both ends, is fitted by grinding, ſo that its lower

lower extremity may reach to the lowermoſt part of the receiver, and conſequently be immerſed in any fluid that may be contained in it. Into the ſmall neck of the receiver D, there is alſo ground a crooked tube I, forming a little more than one fourth of a circle, open at both ends, and extending to very near the lower part of the receiver E, the ſmall neck of which receives a ſimilar crooked tube K; and is received into the wider neck of F, which receives the tube L in like manner, and is received into G, the narrow neck of which alſo receives a crooked tube M N, open at both ends and bent as repreſented in the plate; ſo as to convey any aerial fluid into the ſmall inverted cup, where it is collected and directed to paſs by the hole repreſented in the plate, into one of the four inverted bottles placed above it, by means of the moveable frame P; which having four notches to retain the bottles in an upright inverted poſition, is moveable on the centre ſupport kept ſteady by means of a heavy leaden foot, in the centre of a flat pan of water, which covers the mouths of the bottles. The water which iſſues from the bottles when the air is introduced, and which would make the pan overflow, is directed by a notch in its lip, and the

pipe Q, into the bucket R placed under the frame, which raised upon four legs serves to support the whole apparatus, the different parts of which being successively applied to each other, beginning with the receiver C, are kept in a fixed position by slips of wood hollowed out so as to fit the curvature of the receivers, as represented below detached at S s. Heat is applied to the matter contained in the retort A, by means of the lamp placed below it, which is upon Mr. Argand's principle, and a very useful acquisition to the laboratory: of this 1 represents the chimney which is most conveniently made of thin metal, as brass, copper, or common tinned iron plate, which being opake, the flame of the lamp within is not seen. Metallic chimneys are preferred, because they are not liable to be broken, and because it is the heat and not the light which is here wanted; 2 is the bent wire serving to elevate or depress the wick; 3 the reservoir for the oil; 4 the support of this, with a small cup to receive the oil which may drop from within the wick without being consumed; 5 a pin with its screw for fixing the lamp at any distance from the retort.

Of the Uſe and Advantages of the above Apparatus.

IN the annexed plate, the apparatus is repreſented as employed in the diſtillation of a ſubſtance, the vapours of which condenſe with difficulty, ſuch as the oxygenated marine acid. Let it be ſuppoſed then that the common ſalt, and calx or oxyd of mangancſe have been put into the retort: the vitriolic acid is next introduced by means of a retort funnel; and this being withdrawn, the neck of the retort is immediately introduced into the ſtopper B, the other parts of the apparatus being previouſly diſpoſed as in the plate. The lamp is then brought under the retort, but at a moderate diſtance, that the retort may not be cracked by the too ſudden application of the heat, nor the vapours be driven over too rapidly into the receivers. As ſoon as the heat is applied the ſalt is rendered fluid by the vitriolic acid, and the marine acid getting pure air from the manganeſe, begins to paſs over into the receiver C, in the ſtate of oxygenated marine acid: into this, no water has been put, in order that the vapours of the common marine acid may here be condenſed ſeparately.

The

The vapours of the oxygenated acid meeting with no water here, paſs into the receiver D, where a ſmall quantity is put, by which a part is condenſed, but another part paſſes over into the receiver E; but for this purpoſe it muſt go through the tube I to the bottom of the water which is placed in that receiver, and that part which is not condenſed there, muſt riſe up through it in bubbles as repreſented in the plate: theſe, circulating in the receiver E if not condenſed, will paſs through K, and the water in F into its upper part, and in like manner to L, where if not condenſed, they will be conveyed through the tube M N by means of the cup into the bottles, each of which will in its turn be brought over the little cup, while the others being filled with the air, will be removed and replaced by freſh ones filled with water, without any loſs of the air, or interruption to the proceſs: at the ſame time all inconvenience from the overflowing of the water will be obviated by the tube Q. To thoſe who have been accuſtomed to employ the different kinds of apparatus hitherto in uſe for the diſtillation of the acids, particularly the marine acid, I conceive the advantages of this will be ſufficiently evident; but to thoſe who have had little or no experience

in

in this respect, it may not be improper to mention a few particulars. First then, in this apparatus, there is no necessity for having the retort tubulated, for the neck of the retort being ground into the stopper B, is as easily introduced into that while fitted into the first receiver, as the stopper would be into the superior opening in the retort. This joint is more likely also to be close, as the neck of the retort is expanded when heat is applied, rather sooner than the orifice into which it is inserted, because it is to the retort that the heat is more immediately applied; whereas in the tubulated retort, the reverse of this takes place, the opening being in the retort itself, and the stopper being foreign, and heated only through the medium of the retort. The neck of the retort is ground into the piece B, and not into the receiver C, because the retorts being much more frequently broken, the neck of this receiver would soon be worn out by the grinding; besides in this way, when the retort is broken, the receiver being large, is not so conveniently ground as the piece B, and it is also in this way constantly preserved clean, and never dirtied by the sand or other substances used in grinding. In the receiver D, there is the tube H, which being open at both ends,

ends, but having its lower extremity immerſed in the water, allows a paſſage for the atmoſpheric air downwards, when the vapour is ſuddenly condenſed by the diminution of heat; but prevents the eſcape of the vapour upwards: for when the vapour preſſes on the ſurface of the fluid in D with an increaſed force, a column of the fluid there, is raiſed in the tube which is ſomewhat more than equal in height to the perpendicular altitude of the immerſed parts of all the other tubes taken together.

This tube, which has been called a tube of ſafety, is an uſeful addition to the apparatus, and is ſaid to be the invention of a Mr. Welter. In Mr. Lavoiſier's apparatus there is one to each of the bottles, but this does not appear to me to be neceſſary, as the abſorption is never rapid except in the retort, and the firſt, or at moſt, the two firſt receivers; and in the apparatus here repreſented, there is no crooked tube between the firſt and ſecond receiver, which might convey the liquor of the ſecond into the firſt receiver. When only one tube is employed, the quantity of fluid at firſt put into D ſhould be but ſmall, as a part of that from E may poſſibly paſs over into D.

This

This apparatus has many advantages over any that I have ſeen. Its joints are ground inſtead of being luted, and I always find that the purity of the product is injured by lute, either during the operation, or when the product is removed: as all the joints are concentric, they are eaſily ground; the joints are very ſtrong: many of the joints cover others, ſo that ſome of them may be bad without much injury to the apparatus; any of the joints of the tubes I, K, L, for inſtance, may be bad, with very little inconvenience, as any perſon may be convinced by leaving any of the tubes a little looſe. When a moderate degree of heat only is required, we have no occaſion for a furnace, a lamp anſwering the purpoſe of one completely, and indeed having ſeveral advantages over it.

For firſt, we have the heat more immediately in our power, as we can raiſe, or lower, or remove it altogether, by merely changing the elevation of the lamp, and we have an eaſy rule for this management of the heat, in the velocity with which the air bubbles paſs through the fluid in the different receivers, and in the height of the fluid in the tube H. It may not be improper to remark that when the heat is ſuddenly removed, if the diameter of the

tube

tube H be ſmall, it will be proper to blow a little air through it, leſt the water ſhould get into the receiver D from E.

Secondly, it enables us to eſtimate the weight of the products at any time during an operation: the weight of the retort and ingredients having been previouſly noted, we can at any time during the proceſs that we judge proper, remove the retort, ſtopping the hole from which it was withdrawn with the ſmall ſtopper a, weigh it, and return it, (this need not take up more than half a minute) and in the difference of the weights, we have the weight of the product.

In every caſe where the lamp is ſuddenly withdrawn while the retort is hot, and always when an operation is finiſhed, it will be proper to ſurround the retort with a quantity of dry tow, flannel, or any other rare ſubſtance which tranſmits heat very ſlowly, that it may not be cracked by the ſudden change of temperature: another circumſtance which ſhould be attended to, in order to prevent the breaking of the retort, is, that its neck ſhould be placed with ſuch a degree of inclination, as to allow the drops formed in it by the condenſed ſtream, to run freely into the receiver; as if they ſhould fall back, when the reſiduum in the retort

retort is growing dry, they will certainly crack the hot glafs. In the apparatus which the annexed plate reprefents, this end is accomplifhed by inclining the fupport of the whole apparatus as there reprefented; but it may be done in a way which I have adopted fince that drawing was made, and which feems preferable in fome refpects, particularly in this, that it admits of the fupport being horizontal, which enables us to put more water into the receivers. The retort is made to incline by the hole in the piece B, which receives its neck paffing obliquely through it, fo as to make the end of the retort within the receiver to dip confiderably, while its own external part ground into the receiver C, is in a horizontal pofition: it is perhaps needlefs to add, that by varying the fhape of the receivers, their effect may in fome meafure be varied; thus by making them of an elliptical fhape inftead of globular, if the fhort axis of the ellipfes be placed horizontally, we may proportionally increafe the preffure of the uncondenfed vapour on the furface of the fluid they contain, whereas, if the long one be placed in that direction, we may increafe the furface of the fluid expofed to its action. It feems alfo unneceffary to obferve, that if the ufe of a furnace be preferred

preferred to that of the lamp, all the other advantages of the apparatus remain the ſame; and if the retort be of a large ſize, that a furnace muſt neceſſarily be employed, as the neck of the retort might not be able to ſupport the weight of the matter it contained.

VOCABULARY.

VOCABULARY.

A

ACETITES, ſalts formed by the union of the acetous acid, or diſtilled vinegar, with different baſes.

Acetite of Alum, acetated clay.
— *Ammoniacal*, Mindererus's ſpirit.
— *of Copper*, cryſtals of venus, or diſtilled verdegris.
— *of Lead*, ſugar of lead.
— *of Lime*, acetous ſalt of lime.
Acid Acetous, diſtilled vinegar.
— *Carbonic*, fixed air, aerial acid, mephitic acid.
— *Citric*, lemon juice.
— *Gallic*, gallic acid, aſtringent principle.
— *Muriatic*, marine acid, ſpirit of ſalt.
— — *oxygenated*, dephlogiſticated marine acid.
— *Nitric*, dephlogiſticated nitrous acid, white nitrous acid.
— *Nitrous*, phlogiſticated nitrous acid, ſmoking ſpirit of nitre.
— *Nitro-muriatic*, aqua regia.
— *Oxalic*, acid of ſugar, of ſorrel, ſaccharine acid.
— *Phoſphoric*, acid of phoſphorus.
— *Pruſſic*, colouring matter of pruſſian blue.
— *Sulphureous*, volatile ſulphureous acid, volatile vitriolic acid, phlogiſticated vitriolic acid.
— *Sulphuric*, vitriolic acid, oil of vitriol.
— *Tartareous*, acid of tartar.
Alcohol, ſpirit of wine.

Alumine, earth of alum, pure argillaceous earth, pure clay.
Ammoniac, cauſtic volatile alkali, volatile ſpirit of ſal ammoniac.

B

Barytes, baſis of heavy ſpar.

C

Caloric, matter of heat.
Carbone, pure charcoal.
Carbonats, ſalts formed by the union of the carbonic acid with different baſes.
Carbonat of Alumine, aërated argil.
— *of Ammoniac*, concrete volatile alkali, mild volatile alkali.
— *of Lime*, chalk, aërated calcareous earth.
— *of Magneſia*, magneſia alba of the ſhops, aërated magneſia, muriatic earth.
— *of Pot-aſh*, ſalt of tartar, mild vegetable fixed alkali, ſalt of wormwood, aërated vegetable fixed alkali, ſalt of tartar, mephitic tartar.
— *of Soda*, natrum or natron, marine or mineral alkali, cryſtals of ſoda, aërated ſoda, mild mineral alkali.

E

Ether Sulphuric, vitriolic ether.

G

Gas, gas, elaſtic fluid, aëriform fluid.
— *Azotic*, phlogiſticated air, phlogiſticated gas.
— *Carbonic Acid*, fixed air of Dr. Black, mephitic gas.
— *Hydrogen*, inflammable air, inflammable gas.
— *Muriatic Acid*, marine acid air or gas of Dr. Prieſtley.
— *Oxygen*, vital air, pure air, dephlogiſticated air of Dr. Prieſtley.

Muriats,

M

Muriats, ſalts formed by the union of the muriatic acid with different baſes.
Muriat of Alumine, marine alum, muriated clay.
— *of Ammoniac*, ſal ammoniac.
— *of Mercury corroſive*, corroſive ſublimate.
— *of Pot-aſh*, Sylvius's febrifuge ſalt, regenerated ſea-ſalt.
— *of Soda*, ſea-ſalt, common ſalt.

N

Nitrats, ſalts formed by the union of the nitric acid with different baſes.
Nitrat of Alumine, nitrous alum, argillaceous nitre.
— *of Ammoniac*, nitrous ſal ammoniac, ammoniacal nitre.

O

Oxalats, ſalts formed by the combination of the oxalic acid with different baſes.
Oxalat Acidulous of Pot-aſh, common ſalt of ſorrel.
Oxyd, calx.
— *of Iron, yellow*, ochre.
Oxyds of Lead, calces of lead.
Oxyd of Lead, white, by the Acetous Acid, white lead.
— *of Lead, ſemi vitreous*, litharge.
Oxygen, baſis of vital air, acidifying principle.

P

Pot-aſh, cauſtic vegetable fixed alkali.
Pruſſiats, ſalts formed by the union of the pruſſic acid, or colouring matter of pruſſian blue, with different baſes.
Pruſſiat of Pot-aſh, ſaturated ferruginous, pruſſian alkali.

S

Soda, cauſtic ſoda, marine alkali, mineral alkali.
Sulphats, ſalts formed by the combination of the ſulphuric acid with different baſes.
Sulphat of Alumine, alum, vitriolated clay.
— *of Copper*, roman vitriol, blue ſtone, vitriolated copper.
— *of Iron*, green copperas, ſalt of ſteel.
— *of Lead*, vitriol of lead.
— *of Lime*, vitriolated lime, ſelenite, gypſum, plaſter of Paris.
— *of Magneſia*, vitriolated magneſia, epſom ſalt.
— *of Pot-aſh*, vitriolated vegetable alkali, vitriolated tartar, vitriol of pot-aſh.
Sulphurets Alkaline, alkaline livers of ſulphur, alkaline hepars.
Sulphuret of Antimony, crude antimony.
— *of Pot-aſh*, liver of ſulphur, having for baſis the vegetable alkali.

T

Tartrites, ſalts formed by the combination of the tartareous acid with different baſes.
Tartrite Acidulous of Pot-aſh, tartar, cream of tartar, cryſtals of tartar.
— *of Pot-aſh*, ſoluble tartar.

INDEX.

The letter B *refers to the Second Volume.*

*** When B is placed before the first number referring to a page in any article, it is to be understood that the second volume is referred to through the whole of that article.

A

 linen

Bucket,

N

O

P

Purple,

F I N I S.

ERRATA.

Page 85, line 11, *for* larger, *read* longer.
—— 231, —— 3, *for* aucupatorius, *read* aucupatoria.
—— 353, —— 5, *for* are, *read* is.